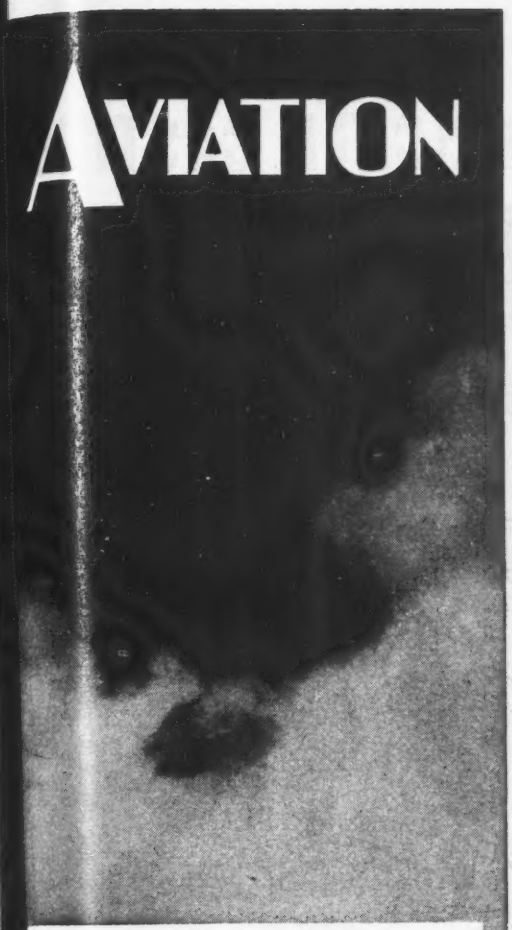

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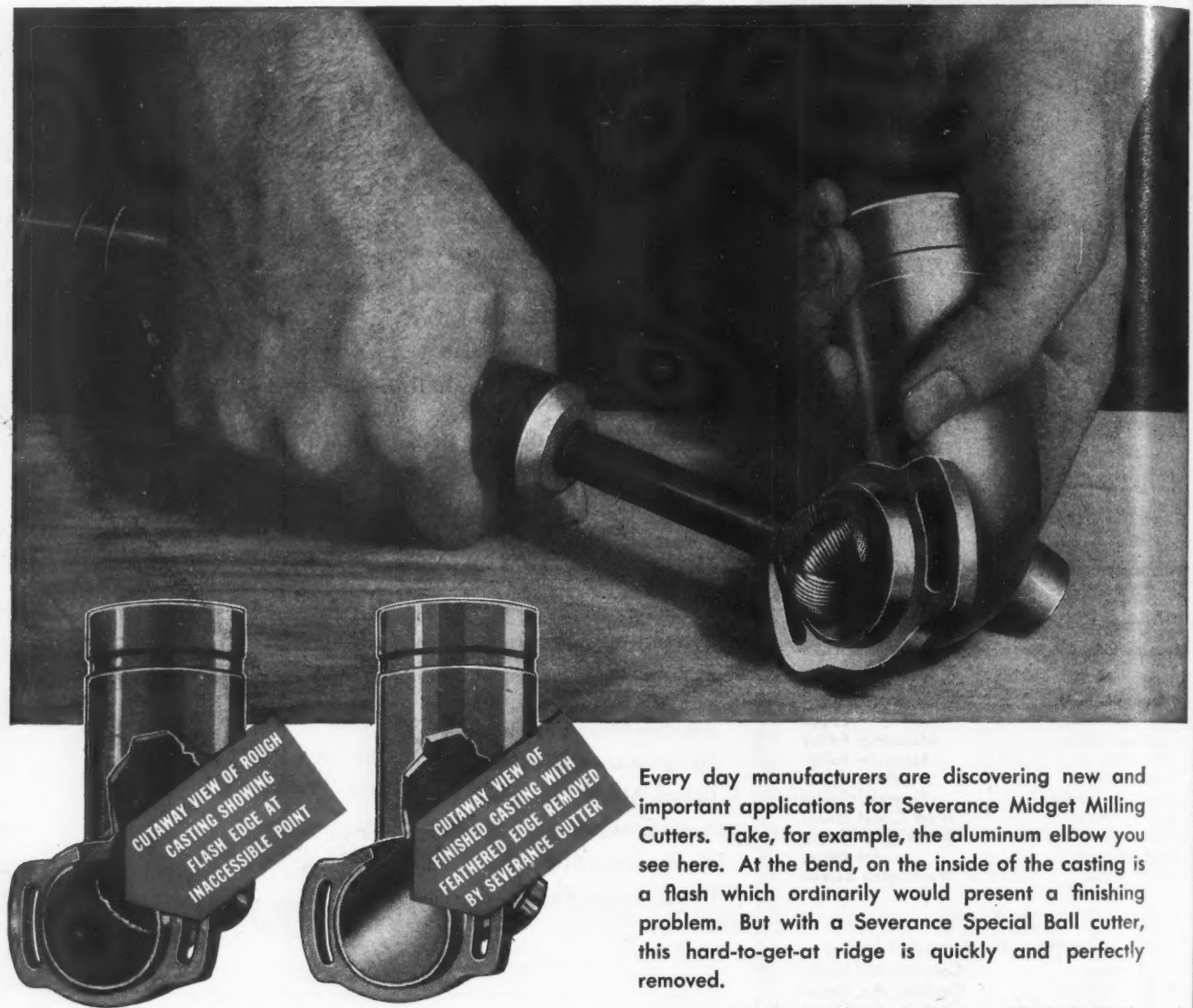
SEVERANCE MIDGET MILLING CUTTER GIVES PERFECT FINISH INSIDE INTRICATE CASTING


CUTAWAY VIEW OF ROUGH CASTING SHOWING FLASH EDGE AT INACCESSIBLE POINT
CUTAWAY VIEW OF FINISHED CASTING WITH FEATHERED EDGE REMOVED BY SEVERANCE CUTTER

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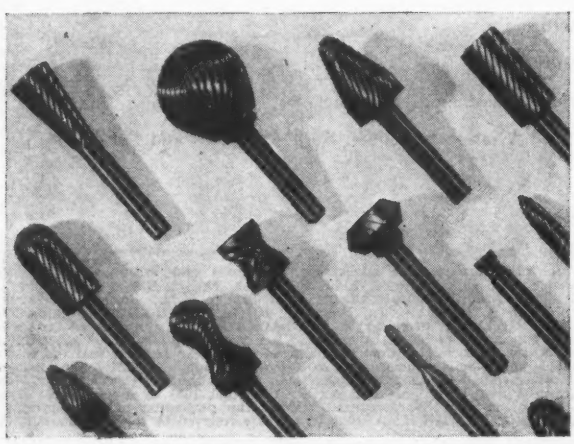

Every day manufacturers are discovering new and important applications for Severance Midget Milling Cutters. Take, for example, the aluminum elbow you see here. At the bend, on the inside of the casting is a flash which ordinarily would present a finishing problem. But with a Severance Special Ball cutter, this hard-to-get-at ridge is quickly and perfectly removed.

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Jet Propulsion

Spurs MORE Than Imaginations

LAST MONTH the Army and British censors saw fit to reveal a few details of one of our most closely guarded military secrets—the jet-propelled Bell fighter. This brilliant engineering project furnishes an excellent example of the fluidity of aeronautical engineering development. It reminds us that the airplane has not crystallized in its present form and that there will be many new and different vehicles to participate in the conquest of the air. It is a warning to those who may have allowed their thinking to keep going in the same old direction. It is one of those projects that inspired our editorial last September about the little old man who made whips. It might be a good idea to turn back and read that editorial again.

The basic idea of a vehicle propelled by a reaction jet is not new. Sir Isaac Newton conceived a horseless carriage bearing a retort-like glass vessel with its neck exhausting rearward. A small fire built under the glass globe heated the water and expanded the air which was expected to rush out the neck and drive the carriage forward by reaction.

Since then thought has been given the thermal jet problem by men of many nations, as recounted in our article, Jet Propulsion—From Fancy to Fact, page 121. A few days before Pearl Harbor clamped censorship upon foreign engineering activities, the Italians flew what was then the latest of several Campini designs from Milan to Rome. In Germany, both Junkers and Heinkel have worked with the idea. So the enemy, too, is familiar with the principles of thermal jet propulsion. But the basic ingredients of our success were the painstaking work of Group Capt. Frank Whittle, the application of principles learned in the successful development of the turbo-supercharger by General Electric, the enterprise and design talent of Bell Aircraft, and the foresight of our Army Air Forces.

THE NEW BELL FIGHTER is reported to have high maneuverability, and exceptional speed and ease of control. Its high altitude performance should be as good or better than it is at lower levels, an inherent advantage of this type of design.

Weaknesses of earlier designs have been chiefly in high fuel consumption and short life of certain elements operating at high temperatures in the power plant. The extent to which these problems have been solved should not be revealed to the enemy at this time. But we have made much progress, reaching the point where no problems are impossible of solution in the application of this principle to high speed aircraft. Every possible encouragement should be given the designers so they may continually improve the military effectiveness of this unique airplane, and the possible commercial applications should not be overlooked.

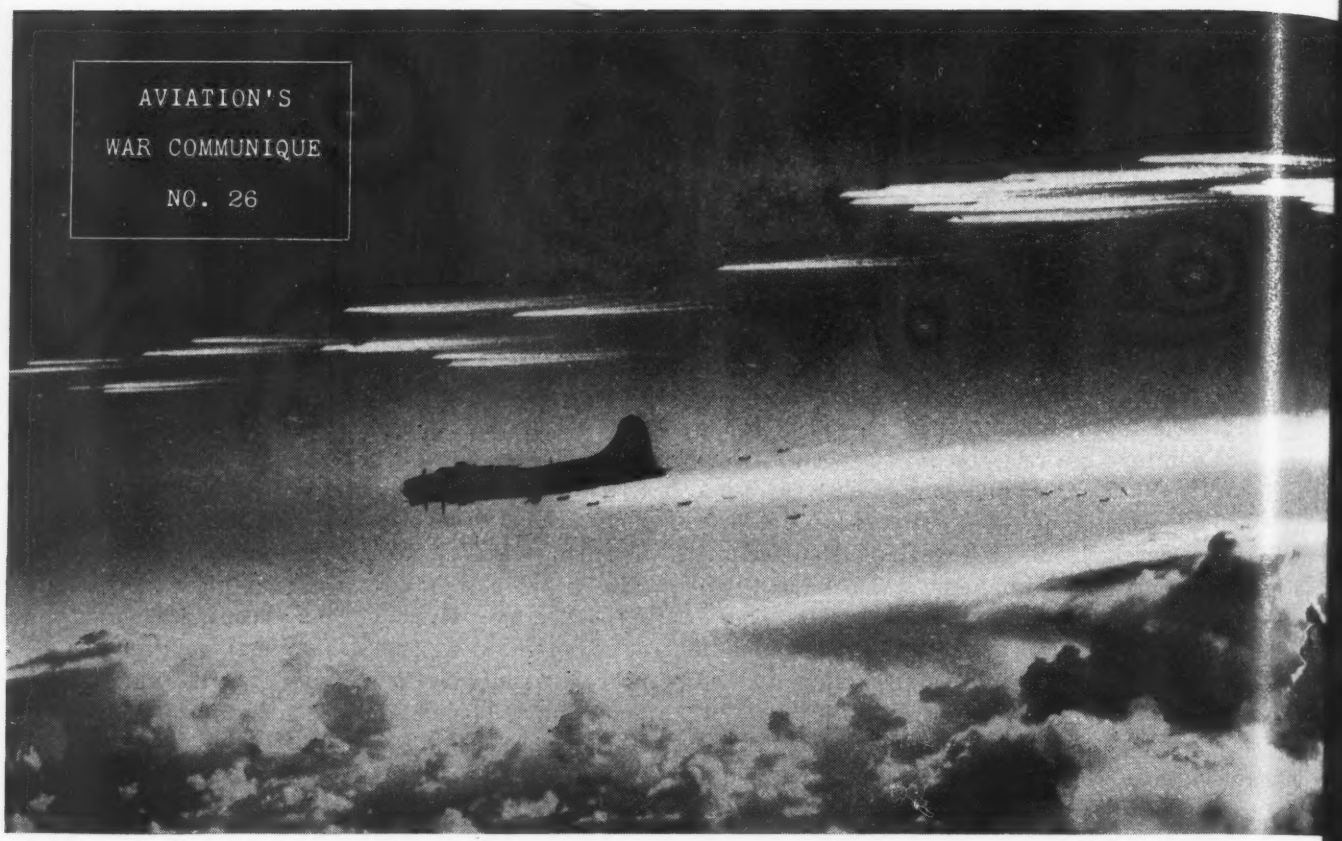
Jet propulsion and rotary wing aircraft, separately and in combination, are destined to take an important part in the postwar world.

IT IS IMPOSSIBLE TO PREDICT ACCURATELY NOW what place these two developments will take in aviation and in our daily life ten years from now. But it is a great injustice to their creators to lead the public to think that they are fully perfected at this time. Already some newspaper columnists have led their readers to believe that there would soon be turbine jets in super-bombers, and helicopters all over the streets. The public doesn't know and the columnists find it unprofitable to learn that engineering miracles take time. Manufacturers engaged in the development of this and other similar projects should resist the temptation to infer that these projects will revolutionize aviation now. There is nothing more devastating to the future of any new technical development than to promise it to the public and then delay delivery.

Speculation as to how the jet propelled plane and the helicopter will revolutionize aviation or how they will take an important place in the diversified field of future air vehicles is not the immediate problem. It is much more important to push their development with all possible speed and give free rein to constructive consideration of their fullest utilization in the achievement of human progress.

Leslie E. Neville

EDITOR



"Allied air power is being so formidably amassed that 3,000 planes are now put into the air on a given day, and this figure can be doubled if the war lasts." Here, AAF "heavies" spew comet-like "contrails" across cold upper sky as they hurtle over Continent to attack Bremen. Foreground *Fortress* has bristling new chin turret ready for Nazi interceptors. (International News photo.)

America at War

Curtain seen falling on Nazis this year, as Allies put 3,000 warplanes in air on single day and invasion becomes imminent. Moreover, Battle of Japan has been calculated and prepared . . . "Helldiver," "Sea Ranger," and "Mars" in spotlight . . . At home, plane production peaks. Reconversion, however, remains big bogey.

NOW INTO THE THIRD YEAR of these air war reports, the editors, who hitherto have stayed out of the hopeful-prediction field, are able to say confidently that they see Germany buckling under the rising power of the Allies. It is certainly factual to take that stand, now that we have the declarations of no less authorities than Adm. Ernest J. King, commander of the U. S. fleet, and Gen. Dwight D. Eisenhower who now heads the two Western sides of the triangle that is about to put on the final squeeze. With our attacks backed by full home-front support, the General says the Nazis will fold in 1944, with no further ifs or howevers.

Evidently the job is going to see a huge Allied walking army put on the Continent. Airmen, in and out of war services in many countries, still believe the haymaker could be thrown with aviation, backed with a larger proportion of available war energy. But nearly everybody agrees that the Allies have a crew of first class generals, and for the time being, even the 150-octane air power advocates must admit that said generals ought to know what they are doing.

Leaving that subject for memoir authors to decide, the walking invasion will call for the big headlines. Whether air attack, in the end, will have done more to floor the enemy than other forces, may become a philosophical question. But in any event, the contribution of aviation will rate tops. To quote Gen. Arnold, "The Army Air Forces has turned out to be our greatest strength and has so far supplied our margin of victory."

The air drive divides into two parts: (1) Strategic damage to Germany's war-making power in factories, transportation, homes, lives, and morale; and (2) tactical disruption of their air and land defense.

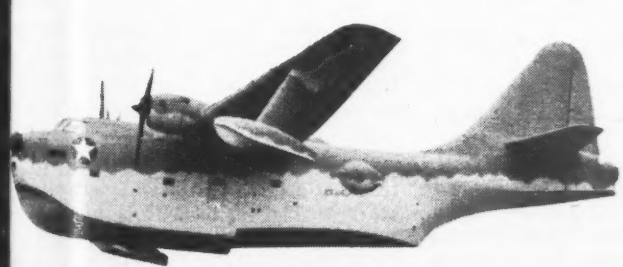
At present, Nazi aviation has chiefly three jobs: (1) Defending the Continent against Allied strategic air operations, (2) tactical support of German troops in Russia, and (3) the same in Italy. It is made plain in all reports that the Luftwaffe is already unable to fight off the Anglo-American air invasions. Especially is it

unable to do so in the face of the newest Allied techniques. One of these is feinting at targets and then hitting others, thus splitting the attack among two or more targets—with the effect both of dividing the defenders fighting planes and leaving much of their mobile A-A fire in the wrong places. Another new technique, months in process of perfection, is bombing through overcast which screens the attackers. It is not quite as accurate as visible attack but, to put it grimly, it gets within city limits. Incidentally, this development will contribute to postwar aviation.

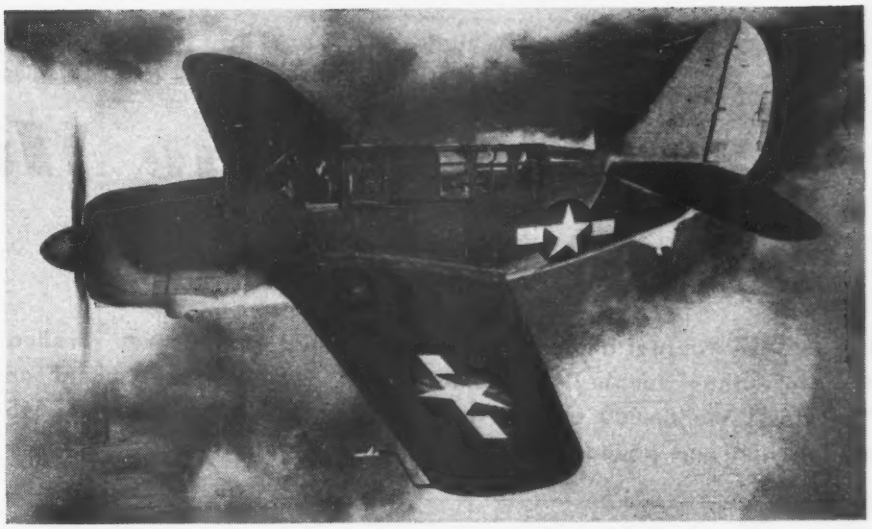
If Goering's air force is unable to meet the current multipronged air thrusts of the Allies, it will be much less able to contend with continuation of the same plus land invasion from several points. It is axiomatic, in this war, that surface operations, on sea and land, must suffer unless they can depend on tactical air support. The Germans, one might guess, can now look forward to taking the medicine they gave to the Poles, the French, the British, and others whom they caught on European soil without any aviation to speak of.

Allied air power is being so formidably amassed that 8,000 planes are now put into the air on a given day, and this figure can be doubled if the war lasts. The United Nations aircraft plants built a total of nearly 150,000 airplanes in 1943, and they could better 200,000 in 1944. Subtracting the losses and whatever will go to the Pacific war, you still get a powerful force to go against Germany's estimated five or six thousand on the line, with about the same in reserve.

Nobody has said anything very definite on the prospect of Russian air attack on Germany. Stalin's aviation is beyond doubt largely tactical, mostly attack and fighter planes, and few bombers. But a tactical air force could go a long way into Germany and shoot up everything in sight. You can make your own guess regarding Russia. However, AAF and RAF are reported readying a Britain-Italy-Russia shuttle bombing program.



Also in news is Boeing's very business-like XPBB-1 *Sea Ranger*, accepted more than a year ago—for Navy now seeks plant capacity for its volume production (Boeing's full wherewithal being given to B-17's and B-29's). Two 2,200-hp. Wrights drive this long-range champion lifter. Integral catapult takeoff assistance is a feature.



High praise was accorded Curtiss-Wright's SB2C-1 *Helldiver* (above) following its striking debut against Japs at Rabaul, where a Nip cruiser and destroyer were chalked up on sunk-list as "sures" and two other cruisers were tabbed, respectively, as "probably sunk" and "heavily damaged." One hundred percent a C-W product—airframe, engine, and prop—this fast two-place all-metal low-midwing craft carries its bomb load entirely within the fuselage belly.

At presstime, the landings on the beaches close to Rome gave new impetus to our Italian campaign.

On the subject of tactical air operation the war in Italy had been a disappointment to the high command, in more ways than one. The scheme of having an Italian army help roll the Germans southward didn't work out. Until official reports are published some day, the facts about the Italian campaign will not be known, but the initial effect of Allied air superiority over Italy fell short of expectations. Our air attack forces assailed the Germans, but the latter held to their lines. Our strategic aviation pounded at the Alps railroads and supply shipping. But these supply lines still worked for the Germans.

The Italian situation is interesting and important. The Germans created havoc with their wailing *Stukas* when they overran Europe. But the Allies, with much better airplanes, weren't having such success in Italy. For one thing, soldiers, especially German soldiers, are no longer afraid of airplanes. The war in Italy might seem to indicate that Allied air superiority over Europe when the invasion starts will not be as effective as expected. Sometimes it seems as if throwing lead and explosive on experienced troops is like spraying powder on bugs in the woodwork. You find they are still there.

The Germans are increasingly expert with their enormous anti-aircraft system. Their gun factories and their scientists are running around the clock, building it up. It will be one of the strongest branches of the Wehrmacht in the final months. Already they are deadly on aircraft up to 20,000 ft. They will raise this altitude, improve their aim, and throw up more metal.

German invention of rockets, glider bombs, and fire disks is the natural outcome of desperation. Chances are that none of these things will become really formidable. The Anglo-Americans and the Germans are too nearly

(*Turn to page* 247)

'43 Output *Doubled the Miracle*

By **HERB POWELL,** *News Editor, "Aviation"*

In fact, the "actual amount of aircraft" rolled off the lines totalled far more than double '42's performance. For with the accent on "heavies," the 86,000 output tipped the scales at an amazing 645 million airframe-pounds—nearly 400 million "up."

AMERICAN aviation today surpasses any business in history. That statement stands without a single "if" or "but" qualification, penned into the record with three '43 exclamation points —86,000 planes, 645 million pounds in airframes, 15 billion dollars in value.

At its very best, the front-running peacetime auto industry climbed to the four billion dollar rung. But our manufacturers had already shaded that remarkable effort a year ago. Point is that they didn't pause to hang up their "Miracle of 1942" citation. Instead they pushed the throttle farther in 1943—and doubled the miracle.

What this is meaning in terms of victory can't be overemphasized, for airpower is proving the determining weapon in this war. Our AAF, now numbering 2,300,000 men—more than all the U. S. branches put overseas in World War I —has been called primary in the blows against the Axis. Along with the Navy and Marine flyers, AAF-men strategically or tactically are keying the fighting of our soldiers on some 56 specific fronts, besides carrying on continual assaults on the enemy homeland.

It certainly bears repeating that these Axis-staggering uppercuts are being delivered direct from the factory. For the roots of this formidable force are the aircraft production lines, the 100-odd prime plants, backed by better than 26,000 suppliers, not to mention the numerous foundries and mills. As is well known, the 86,000 planes they produced is still short of the peak, since a 100,000 yearly rate was surpassed throughout the last quarter of 1943. By way of perspective, each month's production in the last half of the year bettered the total 1939 output. As it was, the 86,000 beat estimated enemy production by a broad 2-to-1, and it bulked up the United Nations' '43 total to close on the 150,000 mark. Over the year, the Germans and Japs could hardly have fabricated a third of that number.

Hitler had counted on seeing it otherwise. Depending on being right where the Kaiser was wrong, he constructed a powerful military machine and clocked it to have the jump on any such American production performance as that which rang down the curtain on the Hohenzollerns. But his 1918 gage proved rusty.

Der Fuehrer's imagination had failed to encompass the tremendous potentialities of the American aircraft industry.

Stalin, recipient of more than 7,000 of the 26,900 planes we exported between Mar. '41 and Oct. '43, had the true phrase for it at Teheran: "Without American production, the United Nations could never have won the war." Note that Stalin—a most realistic man —put extra meaning into his recognition by using the words "have won."

Portrayal of our industry's 1943 production in a tri-part picture of units, pounds, and dollars is our intention in the following columns. But first full credit to the researchers, designers, engineers, managers, executives, and army of workers whose combined brain work and hand work made '43's achievements possible.

Their contributions can't be measured in cold figures. On them depended the union of materials into the finished products, giving new quality in design, structure, performance, engine power. The new efficiencies they developed would take a volume to relate. So would the story of their collating, handling, and transporting victories which licked the bottlenecks.

The striking accomplishments of those in the engine industry stands by itself, as do those of the propeller makers. Then, too, there was the work of the airline men, the modification center men, and the many field men. A single maintenance figure tells a graphic story: Only 4 percent of our planes overseas stood idle for lack of spare parts. And special recognition must go to the NACA scientists who provided that "force behind our air supremacy."

"Smooth sailing" certainly would be an inept description in '43's production story. The men "up front" continually battled with troubles—often heartbreaking—of manpower, material shortages, design changes, modifications, absenteeism, worker relations, renegotiation, taxes, and whatnot.

But let us here accent the results rather than those frequently tortuous methods of their achievement, which is the concern at all other times. The fact remains that troubles solved in '43 were more numerous than those that weren't.

The year ended with manpower matters better, the incentive plan (for instance) being termed helpful. CMP had worked well to overcome shortages of primary materials. The Navy made a particular point of stating, in December, that it found no critical bottlenecks.

For that matter, even the mid-year "level-off" was not a "disease" of the

1943 Monthly Aircraft Production By Units and Weights

	Number	Airframe Production, In Millions of Lb.*a*	Average Airframe Weight Per Plane, Lb.*a*
Jan.	5,013	30.3	6,040
Feb.	5,453	35.5	6,510
Mar.	6,264	41.0	6,545
Apr.	6,472	45.6	7,046
May	7,114*b*	50.5	7,099
June	7,094	53.6	7,556
July	7,373	56.0	7,595
Aug.	7,612	59.5	7,817
Sept.	7,598	61.4	8,081
Oct.	8,362	66.7	7,977
Nov.	8,789	71.2	8,101
Dec.	8,802	73.6	8,362
	85,946	644.9	7,504*c*

a Airframe is defined by the WPB and AAF as an airplane, less engine, armanent turbosupercharger, propeller (incl. hub, blade, power control, and governor), starter, wheels, tires, tubes, auxiliary power plant, radio (incl. receiver, transmitter, and removable units, but not installation parts and wiring), batteries, generators, turrets, and power-operated gunmounts. This definition has been in effect since May 1943.

b Includes 27 target planes. Army decided not to count these, thus gets figure of 85,919 for year.

c Average weight for year.

Fig. 1. Steady war-winning production rise is traced by climbing figures in number-and-poundage breakdown of '43 airplane output. Note (right-hand column) how average weight of airframe jumped from 3 tons to more than 4 in the 1943 span, indicating increased production of bombers. Year's average of 7,504 lb. may be compared with 5,287-lb. figure for '42 and 3,945 lb. for '41. Foreseen for '44 is an average weight per airframe surpassing 9,000 lb.

whole industry. Rather it was a lag of but two or three plants. And even then, part of the trouble, at least, may be foot-noted as design-change expediencies.

And now to units-pounds-dollars—

Units

As shown in our month-by-month addition (left hand column in Fig. 1), the precise 1943 total of powered craft was 85,946 (or 85,919 in the WPB-Army reckoning, which does not include a parcel of 27 target planes in the total of operative aircraft). It is worth remarking that the *climb* of 3,789 planes in monthly production rate—from 5,013 in January to 8,802 in December—was itself virtually equal to entire 1937 output. Incidentally, the presentation of this monthly break-down is noteworthy, since such figures were not released for '42. They were afforded in '43 in line with Donald Nelson's declaration that "Our production position is now so strong that information concerning it will be of no aid to the enemy." Even the 85,946 is not the whole picture, for gliders were not included in the total.

Perspective of '43's huge number production—in contrast with '42's, which it virtually doubled, and '41's, which it almost quadrupled—is offered in the top portion of Fig. 3, along with a projected output for '44.

Highlight in the unit production story was the "up" in heavy bombers. From time to time during the year, word came through of boosts in the "heavy" category, and pieced together they now give a striking picture of the growing flow. The industry's output of "big stuff" was hitting in the 200's at the first of the year, by March the 500 figure was passed, by August the 700 figure. Then in November more than 1,000 came off the lines. And the record went far over that in December.

Accent to '43's doubled miracle came in the latter part of '43 when the troubles behind the mid-year "level-off" had been accounted for. November and December saw a plane turned out every five minutes—more than 280 every day. The schedules were constantly ranged ahead, yet in those months deliveries were but a notch or two short of a perfect 100 percent. Best monthly rises were March (up 811 planes) and October (up 764).

Including the December production, it was calculated that a sky-clouding mass of no less than 157,000 airplanes had been fabricated by American plants since July 1940. It was significant, in looking back, that the 100,000th craft came from the lines on Memorial Day—a prophetic prememorial for the Axis "supermen."

A few more facts are worth remarking: As of the fiscal year ending July 1, the Army had accepted more planes

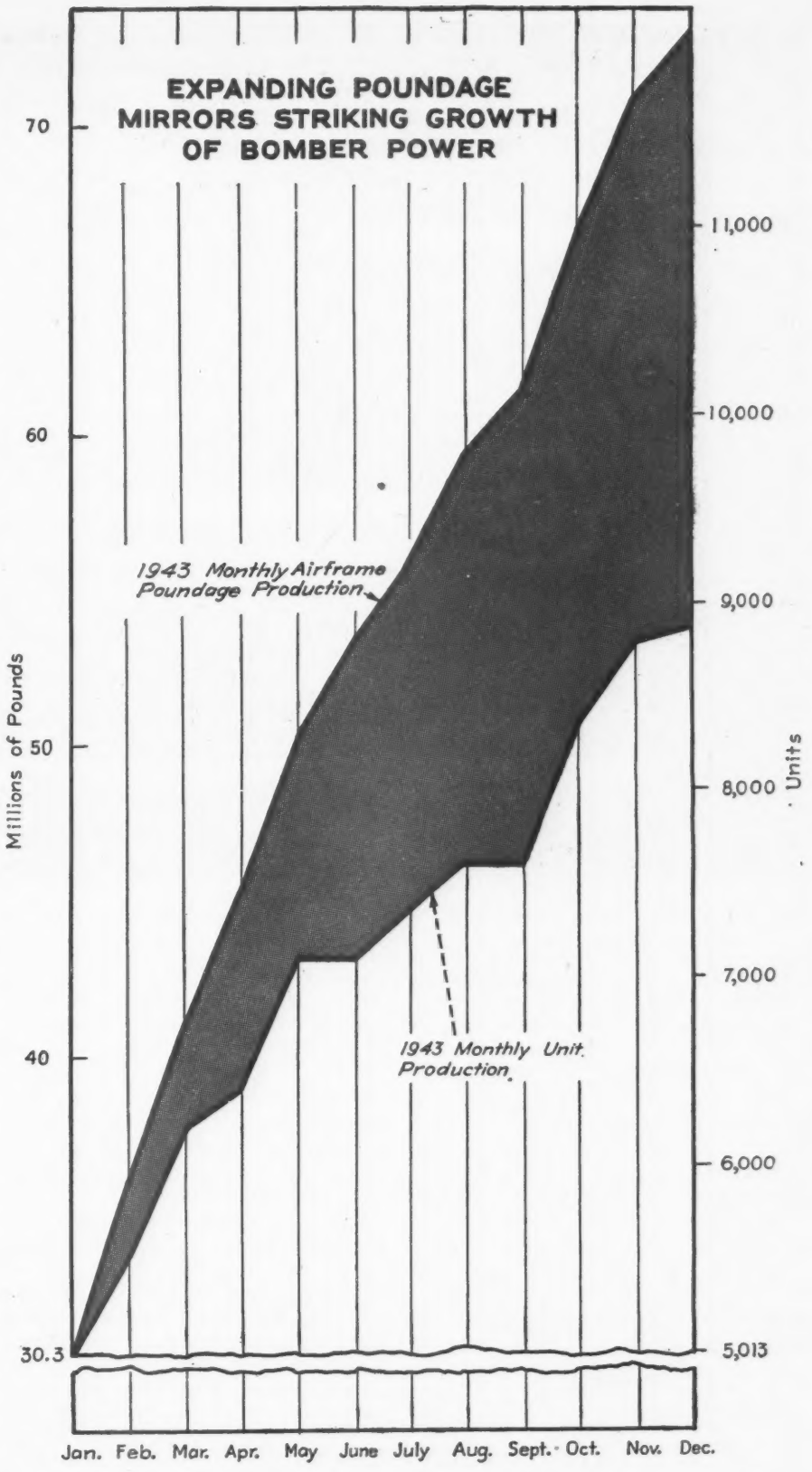


Fig. 2. Signal 1943 airframe poundage gain is graphically portrayed when weight and unit output lines are combined in single chart. Starting with January's 5,013-plane and 30,300,000-lb. airframe production as "scratch," weight line immediately soared above unit production line, and spread steadily increased until there was marked gap at year's end, indicating big "up" in output of "heavies." That poundage is more precise production measure than units is quickly evidenced—for though unit line shows September production dropping slightly under August, the weight line readily proves that month's output was actually decidedly higher than that of preceding month, and same was true in May-June instance.

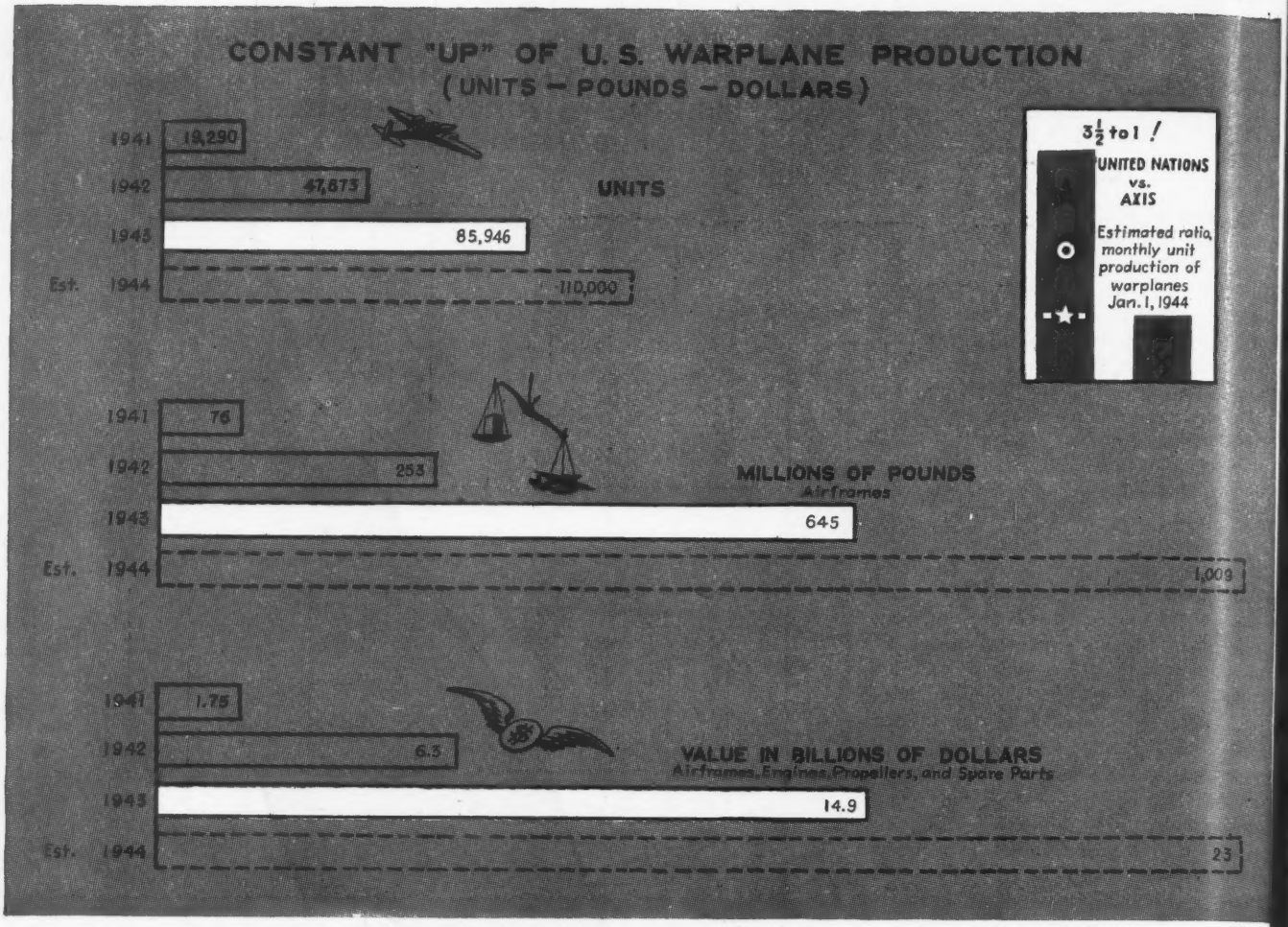


Fig. 3. Spectacular production punch that aircraft industry is now crashing against Axis is triply illustrated in this units-pounds-dollars chart, graphed with '41 as a base. A year ago, the "Miracle of 1942" saw '41 units more than doubled, airframe pounds more than tripled, and the dollar value likewise more than tripled—but even these amazing records were far outdistanced by production in 1943 when '42 units were virtually doubled and poundage and value were better than doubled. And the peaks, projected in our '44 dotted-line estimates, still lie ahead. At first of year, United Nations' total monthly unit warplane production was figured at triple-and-a-half output of Axis, with that of U. S. scoring better than 2 to 1. This victory ratio (portrayed in inset, upper right) is being further widened with each new production "up" and each new blow at enemy output. Note that our airframe-poundage totals would be higher if spares were included. Calculations above are according to WPB-Army airframe definition (given in Fig. 1 footnote).

than in the preceding 33 yr. It was noted on that date that the Army had received 73,132 craft in the foregoing 18 mo.—bringing the "take" to 4,500 planes every 30 days.

As for the Navy, combat plane deliveries ran into four figures by April. And calculating the full year its force of planes rose 280 percent, roughly from 5,800 to 16,000.

Poundage

Vivid though all these unit figures are, however, it was poundage which stood revealed in 1943 as the truer gage of production. This fact is readily apparent in Fig. 2, where monthly airframe weight lines and monthly unit production lines are graphed on one chart. Had the same-weight planes been scheduled in December as in January, the weight line for the year would have gone right along with the unit line. But, as seen, the weight line immediately rose over units, kept climbing, and by December had demarked a very wide gap. The spur to weight was the highly augmented production of "heavies"—indeed nearly all craft were giving a greater pull on the scales.

Thus, '43 showed distinctly that poundage—that is, "amount of aircraft"—gives the more precise record of production performance, since unit figures fail to mirror such amounts. By this more logical criterion, production soared steeply throughout '43.

True enough, the public can more readily comprehend numbers of planes, all of which is understandable, but the unit gage was 'way off in more than one instance in the year. Note the May-June and August-September "level-offs" on the unit line in Fig. 2—then lift the eye and observe the coincident rising weight lines for those periods. Actually, there were recorded neat 3,100,000-lb. and 5,300,000-lb. "ups" in "amount of aircraft" in those months.

The airframe-weight figures are given in the second column of Fig. 1, and the average weights—showing a 3- to 4-ton rise over the year—appear in the last column. The total airframe poundage, estimated at 747 percent over that of '41, does not include engines, propellers, and numerous other items.

With the spares added, the weight figure would be high in the 700 million range. Airframe weight records through the years are depicted in the mid-portion of Fig. 3.

One more word on poundage vs. units: Early in 1943, a production of 100,000-plus planes was foreseen for '43 by some figurers. And consequently certain of the unknowing would now have it that the year's production didn't jell so well. However, this concept is shown to be quite faulty in the light of weight. For the fact was that, in the different schedule changes, units were translated into poundage. That is, units were revised downward and poundage was revised upward as the heavy bomber program got well underway.

If the questioners wish to mentally

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Five Hurdles to Helicopter Perfection

By LOU LEAVITT,

Former Test Pilot, Pitcairn, Kellett, and Platt-LePage Companies, and Now Rotary Wing Consultant for Two Major Manufacturers

True enough, today's 'copter has "run the course" as a successful flying machine—but it must clear the engineering obstacles with more to spare before it wins rank as a practical product.

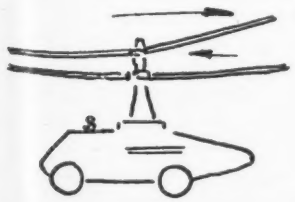
WITH SKETCHES BY THE AUTHOR

THE IDEA OF THE HELICOPTER is not new. It is as old as the idea of flight itself. But the recent rapid strides it has been making toward success are very new indeed.

From the inception of the idea itself, way back in the eighteenth century, up until the present time, there have been a number of isolated individuals and organizations working on it, more or less spasmodically and with no great degree of success. Spread over these years, a great deal of money has gone into its development. But the coming years will see that outlay of money increased many fold, and almost all of the larger aircraft companies, along with innumerable smaller organizations, will take part in the development. This is due, of course, to the promising potentialities attendant upon the helicopter's first real success as an aircraft.

From the start, the potentialities were there, awaiting an impetus to bring them to the attention of the aviation industry. It is regrettable that this could not have been supplied sooner. Yet it is very understandable that it did not, and in a way this manner of progress offers signposts which we would do well not to overlook in our newborn enthusiasm.

For the helicopter has matured slowly, held back alike by its own inherently complex problems and by the rapid advance and spectacular achievements of the airplane. There is no doubt that, with the current interest and facilities, it will now develop far more rapidly; yet if we lose sight of its past, we may

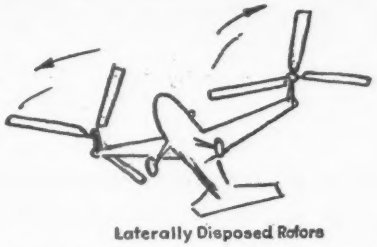


Co-Axial Rotors

easily find its future based upon false assumptions. Theoretically, the helicopter has always been a sound idea. Practically, it has been—and still is—beset by many major problems and no few minor headaches.

The problems can be grouped roughly into five main categories: Power-plant and propeller combination, lift, control, stability, and rotor vibration or roughness. All of these have been solved to the extent of producing a successful flying machine. But none of them has been solved to the extent of making that machine a finished product. This is very important, for we are apt to see in the solutions the ultimate goal we are seeking rather than the means to that goal.

The very history of the helicopter development leaves the craft peculiarly vulnerable to this type of conclusion, for its progress followed always in the wake of other developments through adoption. Relatively early, the first problem was solved—with the advent of the gasoline



Laterally Disposed Rotors

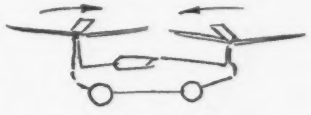
engine in airplane construction, and it became necessary then only to adapt this solution by overcoming the torque reaction incident to a power driven rotor. Almost every type that was ever attempted was successful to this extent.

But what happened to the machine once it left the ground was something else, for keeping it right side up (let alone going anywhere with it) was at that time seemingly an unattainable ideal. It remained an unattainable ideal for many years, then again its solution followed in the wake of another development. It was the autogiro this time that led the way, and the most successful helicopters today still use basically the same rotor theory, including similar blade structure and airfoil sections, fully articulated blades, and the safety factor of auto-rotation.

The problem of control was solved similarly by following autogiro development, that is in using the lift vector of the rotor and its relationship to the center of gravity location of the machine as a means of attaining that control. This was accomplished, as in the autogiro, through changing the plane of the rotor in flight either by tilting the rotor head or by altering the blade path cyclically to tilt the vector.

The problem of stability is perhaps more peculiarly the helicopter's own, though again we have adapted the airplane's standards to what knowledge we could gain of rotor characteristics through the autogiro. In many cases it proved to be a controlled stability rather than inherent, but it was at least sufficiently effective to eliminate any unfavorable characteristics that might develop.

Last, but certainly not least, remained the problem of rotor vibration. There



Tandem Rotors

is probably less known about this even now, at least constructively toward effecting a cure, than about any of the other problems confronting the helicopter. It is so intrinsically tied up with other rotor characteristics that it is almost impossible to isolate it as a problem by itself. Yet a problem it certainly is, for it has beset rotary-wing development from its beginning. If it has been solved at all, it has been solved only to the point of making the machine an operable aircraft. It has never been wholly eliminated. On the other hand, it has not been responsible either for all the evils ascribed to it.

Through the solution of these five major problems, the helicopter made its slow and halting progress toward maturity. But in accepting the solutions it was necessary to overlook whatever disadvantages were incurred in their adaptation. The important thing was to make the helicopter fly—to prove its feasibility as an aircraft. This has been done. If there was little time to worry about refinements and minor perfections in its accomplishment, there is now the whole future progress of helicopter development before us in which to work out these details.

We have come a long way from the original conception of the idea, but transforming a sound theory of flight into a successful flying machine is not by any means the whole of its goal. It remains now to perfect that machine by making it a useful and practical aircraft that will fit the aviation needs inherently adapted to it. For, until the helicopter has finally achieved this, it cannot as-

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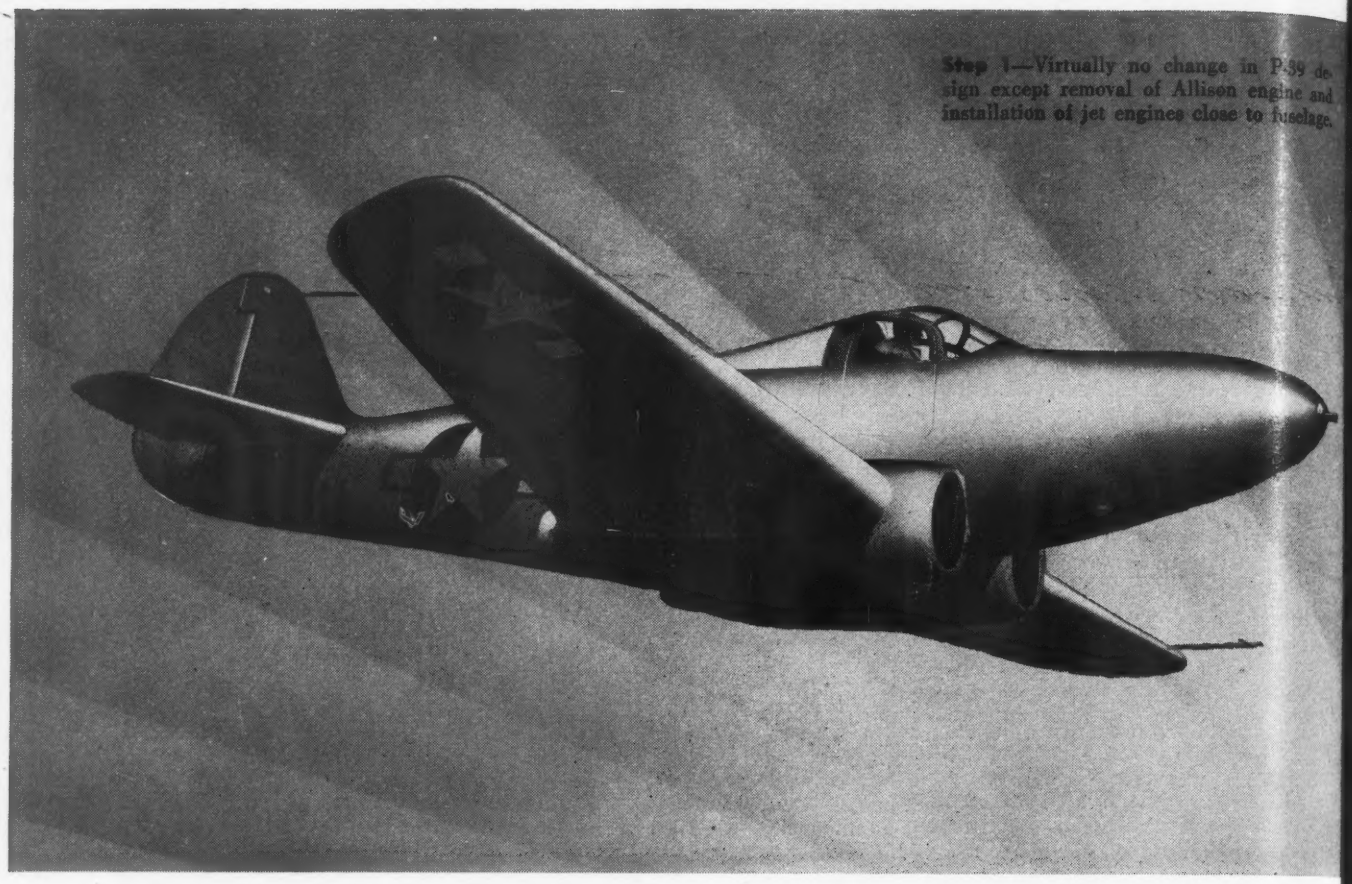


Step 1—Virtually no change in P-39 design except removal of Allison engine and installation of jet engines close to fuselage.

. . . And Now the

JET PROPELLED AIRPLANE

By E. EUGENE MILLER, *Managing Editor, "Aviation"*

From the few details released on the recently announced jet-propelled airplane, some interesting conceptions of the P-39 *Airacobra* as a jet airplane can be drawn.

BELL AIRCRAFT CORP. and the General Electric Co. shared honors in the recent announcement revealing the successful flights of a super-speed jet propelled airplane.

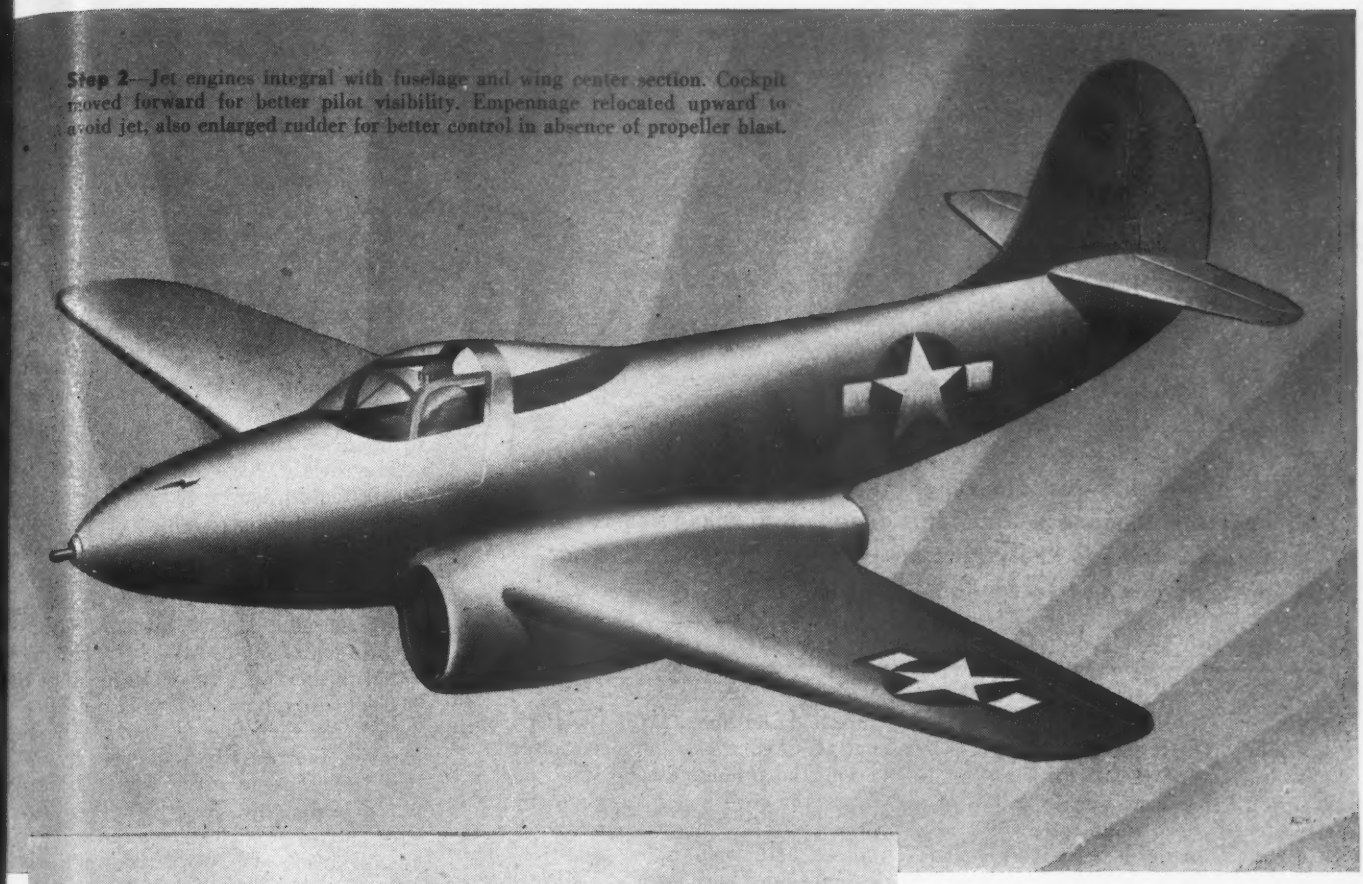
General Electric's part in this historic development was construction in this country of a British jet engine designed and pioneered by Group Capt. Frank Whittle since 1933. The Whittle engine, one of many under development during the past decade, proved feasible and, in fact, enjoyed some prominence after various successful test flights in England in 1941.

From reports, the Whittle engine consists of a high-speed blower-type rotary compressor driven by a single-rotor turbine. These components are mounted in tandem in a cylindrical chamber. Air is taken into the chamber either through a front orifice, or any other suitable collecting device, and is directed into the compressor through two intakes. Compressed air is then taken to a heating chamber fired by kerosene or some other adequate fuel. The gas and air mixture is then directed to the discharge conduit in which is located the turbine shafted to the compressor. Part of the energy of the heated air is given up to the turbine upon re-expansion, and the remainder is exhausted at high velocity through a discharge orifice. A very considerable thrust is developed through reaction to this high velocity discharge.

It was logical that General Electric, with its background as developer of the turbosupercharger, should be asked to apply its experience to the modification and perfection of the Whittle engine. This was accomplished in less than six months.

At the same time, Bell Aircraft was assigned the task of designing and building a high performance airplane to be powered by two of these General Electric engines. Work proceeded immediately under the guiding hand of Engineering Director Harland M. Poyer, and in twelve months the makers of the famed P-39 *Airacobra* emerged with the history-making plane. Chief Test Pilot Robert M. Stanley made the initial test flight in Oct. 1942. Since then, hundreds of flights have been made without mishap.

No details have been revealed on the Bell airplane, but it is known to be a twin-jet craft, and if reasonable conclusions are drawn from recent Bell advertisements, the craft would be very similar in appearance to the P-39 *Aira-*



Step 2—Jet engines integral with fuselage and wing center section. Cockpit moved forward for better pilot visibility. Empennage relocated upward to avoid jet, also enlarged rudder for better control in absence of propeller blast.

Left: Conventional P-39 offers points of comparison.

cobra. A glance at the *Airacobra* would reveal very little space in the fuselage for two jet engines, and any redesign of the fuselage to provide for such an arrangement would be very major in character. A simpler solution would be to mount each engine in the wings, encased in normal streamlined nacelles quite close to the fuselage in the absence of propellers. Because of critical airflow over the wing-top surfaces of a high wing-loaded aircraft, it would seem that the nacelles should be more or less underslung to avoid interruption of airflow over the regular P-39 airfoil. However, the obvious attendant structural difficulties could be resolved by wing redesign utilizing, perhaps, a laminar flow wing being adopted by several manufacturers of conventional fighter planes. At the same time, the engine nacelles might be made an integral part of the fuselage, mounted on the P-39's sturdy wing center section. At any rate, in aspect a jet-propelled Bell airplane might readily take on the form of a twin-engined *Airacobra*.

As a matter of fact, a jet-propulsion arrangement could be readily incorporated into the P-39 design. Unlike conventional fighters, the normal engine installation is behind the cockpit approximately at the center of gravity. The propeller is driven through a shaft extending from the Allison engine to a propeller gear box in the nose. Removal of this engine would not seriously affect the airplane's balance. Most of the modifications involving weight would take place at approximately the C.G. location. This would apply in the instance of locating the jet engines in the wings close to the fuselage, and a generous fuel tank could be installed in the Allison engine cavity. Because of this happy state of affairs a minimum of design changes would have to be made in the P-39.

It is possible that some modification would have to be made in the empennage. Absence of propeller blast would mean different forces acting on the control surfaces, and jet heat may necessitate some relocation. Furthermore, some changes would have to be made in the main landing gear because normal retraction is inboard and it is probable that the jet engine installation would interfere with this arrangement. However, length of the struts could be reduced because of no need for propeller clearance, and the foreshortened gear might still be retracted inboard, the wheels nesting short of the nacelles.

It is quite probable that photographs of the actual Bell jet airplane will be released before this issue's press run is completed. The above sketches are not intended to resemble that craft but merely attempt to show what might be done to the basic P-39 design to accommodate jet engines.

Securities Gain—The Hard Way

By H. L. FEDERMAN

After fighting over the toughest of financial terrain, the aircrafts still manage to forge ahead. But unknowns fog the future. And it's likely that many new—and even tougher—hazards are yet to be faced.

DESPITE CONSTANT UNCERTAINTIES, the aircraft industry has recorded substantial progress in its financial development in recent years. Values have consistently been augmented.

As a consequence, considerable substance has been imparted to aircraft book valuations.

The nature of the assets actually comprising these valuations presents an important qualification, but the fact remains that the equity interest in aircraft properties has been steadily on the rise and as yet shows no sign of a reversal in trend.

These gains can be attributed almost completely to earnings. The relative small capitalizations prevailing in the industry have accentuated this condition. A large volume of sales, making for a rapid turnover of capital, has helped place some fat on the bones of the aircraft industry despite the low profit margins. (During 1942, profit margins for the aircraft builders averaged 2.7 percent. This compared with 6.7 percent for general industry.) In a few instances, new stock issues have supplied additional capital to the group, but this experience has been a rarity.

On the whole, during the past six years, the government, through one form or another, has financed most of the required additional plant facilities. This circumstance may have solved the pressing financial needs of the industry existing at the time, surely was not without its beneficial effects. The aftermath, however, promises many unknowns which can jeopardize whatever earnings may have been allowed to accumulate thus far.

The extensive use of banking credit, supplementing government advances and other assistance, has provided considerable leverage to earnings on aircraft capital. In other words, while profit margins are extremely low, the judicious use of capital makes for larger returns on the equity investment. To illustrate, assume a company has a 3 percent profit margin on sales but turns its capital over only once during the year. Its return on the investment is then but 3 percent. However, assuming the same profit margin, but with a capital turnover of 4 times annually, a return of 12 percent will be realized on the investment.

Going a step further, if a company can obtain a loan at a low interest rate, say 2 percent, it has the use of such funds many times over during the year, to say nothing of the differential existing through the low interest rate. That is leverage, and it is mainly responsible for the large returns reported on invested capital by many aircraft companies.

Conversely, this trading on the equity carries with it many risks, and a sudden reversal of trend can prove disastrous to financial structures.

The steady climb in asset values is illustrated in our accompanying Table I. Here, figures for eight major aircraft companies are offered covering the six year period 1938 to 1943 inclusive. Expressed in terms of net assets per share, a simple and concise measure is provided facilitating ready comparisons.

Supplementing this data, Table II presents earnings, dividends, and price ranges for the same companies. In this manner, the contribution made by residual earnings to asset values becomes readily apparent. In view of frequent surplus and other adjustments, an exact reconciliation of earnings and asset gains becomes almost impossible.

The price ranges (Table II) also provide an indication as to how market appraisals have compared with indicated book valuations. Current market prices, in almost every instance, are very close to the low figures shown for 1943. This may be contrasted with the asset valuations as presented for the most recent period available and reveals the existing disparities in prices. (Asset valuations for 1943 are our own estimates and are based upon the general assumption that earnings for that year will be about the same as for 1942. Actually, 1943 earnings will probably be much improved over that for 1942.)

It is with this background that each of the companies presented may be examined in specific terms while at the same time those characteristics common to the industry as a whole may be placed in proper perspective.

Bendix Aviation shows a gain of about 64 percent from the 1938 year-end to Sept. 30, 1943, asset values rising from $13.09 per share to an estimated $22.50. During this period, a slight increase in total shares outstanding took place, but this was without material effect on the results shown. At last reports, there were a total of 2,113,289 shares outstanding, compared with 2,097,608 in 1938. Considerable progress is in evidence for this company. Earnings rose from seven cents a share in 1938 to $5.90 for 1942. Fairly respectable dividends have been paid throughout the years.

TABLE I—Trend of Net Assets Per Share of Eight Major Aviation Companies In Terms of Common Stock, 1938-1943

(Source: Moody's Industrial Manual for 1943 and company reports, with author's estimates for 1943)

	Bendix *a*	Boeing	Curtiss-Wright	Douglas *b*	Martin	North American *c*	Sperry	United Aircraft
1938	$13.09	$9.83	$3.71	$18.97	$12.82	$2.12	$6.12	$10.48
1939	13.76	5.33	4.04	23.03	16.40	2.79	6.83	12.24
1940	15.10	8.89	5.17	35.99	19.21	3.60	8.72	13.68
1941	17.69	14.65	7.07	59.37	21.47	4.62	10.83	14.93
1942	19.64	19.70	9.03	76.13	25.98	6.41	12.20	14.33
1943 est	22.50	22.50	10.00	90.00	29.00	7.50	13.50	17.25

a Years 1938 and 1939, ending Dec. 31; 1940 to 1943 incl., ending Sept. 30.
b Years ending Nov. 30.
c Years 1938 to 1940 incl., ending Dec. 31; 1941, nine months to Sept. 30; 1942 and 1943, years ending Sept. 30.

General Motors Corp., the largest single stockholder in Bendix, has accordingly benefited from such payments. Other advantages have also accrued to General Motors, indirectly, as a result of this relationship.

Bendix market values have held up better than those of any of the other companies presented. In fact, the common stock, throughout 1943, has consistently sold at levels higher than those prevailing during the previous five years. This condition is unequaled by any of the other aircraft equities. The market esteem accorded Bendix is due to the company's wide diversification and flexibility in shifting emphasis from one industry to another. For example, it is an easy step for Bendix to return to automotive parts manufacture and thus avoid many of the postwar problems facing the prime aircraft builders.

Closely akin, but not as impressive as Bendix, are the earnings and market record of Sperry. Contrary to popular belief, this company does not have its dominant activity centered in aviation. Naval and other industrial specialties provide a considerable percentage of Sperry's volume. Asset values have mounted from $10.48 per share in 1938 to an estimated $17.25 at the 1943 year-end. The capitalization, consisting of 2,015,565 shares outstanding, has remained unchanged throughout the years. Earnings have been fairly stable, ranging from $2.46 a share in 1938 to $4.11 in 1941 and down to $2.87 in 1942. Dividends through the years have been at the rate of about one-half of available earnings. While the market price of the stock has declined from the price peaks of 1938 and 1939, it nevertheless has held up better than the equities of the airframe manufacturers.

An interesting sequence is presented for Boeing. After an abrupt decline in asset values from 1938, as a result of deficit operations, a constructive turn took hold in 1940. As a result, asset values rose from a low of $5.33 per share at the 1939 year-end to an indicated $22.50 at the close of 1943. This represents a gain of about 320 percent. Earnings are clearly in evidence with dividends limited.

Additional stock has also been a material factor in Boeing's record. A total of 721,958 shares were outstanding during 1938 and 1939. In May 1940, new stock was sold at $16 per share, bringing the total capitalization to 1,082,454 shares, where it has since remained. This sale, of course, bolstered book values of the existing equity. The market action follows the typical erratic pattern of the aircraft industry, constantly coming down.

Curtiss-Wright shows an increase of about 170 percent, or from $3.71 per share in 1938 to an estimated $10 at the end of 1943. The large capitalization outstanding has been a burdensome market factor for Curtiss-Wright. There are 1,158,702 common shares presently outstanding. To this must be added 7,432,206 shares of the Class "A" stock which, for practicable purposes, serves as a weight for the common. Nevertheless, despite having a range confined between 3¼ and 13¼, the common stock has presented many profitable trading opportunities. For example, a purchase at $5 per share and a sale at $10 would result in a 100 percent gain.

The most phenomenal results appear to be offered by Douglas. From $18.97 per share in 1938, asset values rose to about $90 for 1943, or a gain of about 375 percent. The reasons are not hard to find: Good earnings, limited dividends, and small capitalization. The 600,000 shares presently outstanding represent the smallest stock capitalization of any of the major aircraft companies. Yet Douglas has fared only slightly better in the market than other aircrafts. At current prices, Douglas is selling at less than half of its peak points of 1939 and 1940 and has equalled the lows established during 1938.

Martin has also made major gains in asset values. From $12.82 per share in 1938, a gain of about 125 percent was made, with an indicated $29 reached for 1943. Total stock outstanding has increased silghtly through the years, amounting to 1,107,022 shares at the 1942 year-end. Earnings, of course, contributed to the increase in asset values. The market action of Martin is the familiar one for the aircraft industry.

North American Aviation gained about 253 percent in asset values during the period reviewed. General motors also has an interest in this aviation company, owning, at last reports, 1,000,061 shares or 29.11 percent of the 3,435,035 total shares outstanding. In terms of market action, however, North American has hardly repeated the pattern traced by Bendix. But dividends have been fairly liberal in relation to earnings.

The most surprising results were recorded by United Aircraft. Since 1938 and through 1943, asset values per common share rose from $10.48 to an indicated $17.25 or only about 65 percent—the lowest gain for any of the prime aircraft companies reviewed. However, liberal dividend payments have been made, relative to available earnings. It is possible substantial surplus adjustments may have been made, bringing asset appraisals down to low levels.

It is an outstanding observation that Bendix, Sperry, United Aircraft, and North American Aviation are the only companies whose stocks are currently selling above their respective book

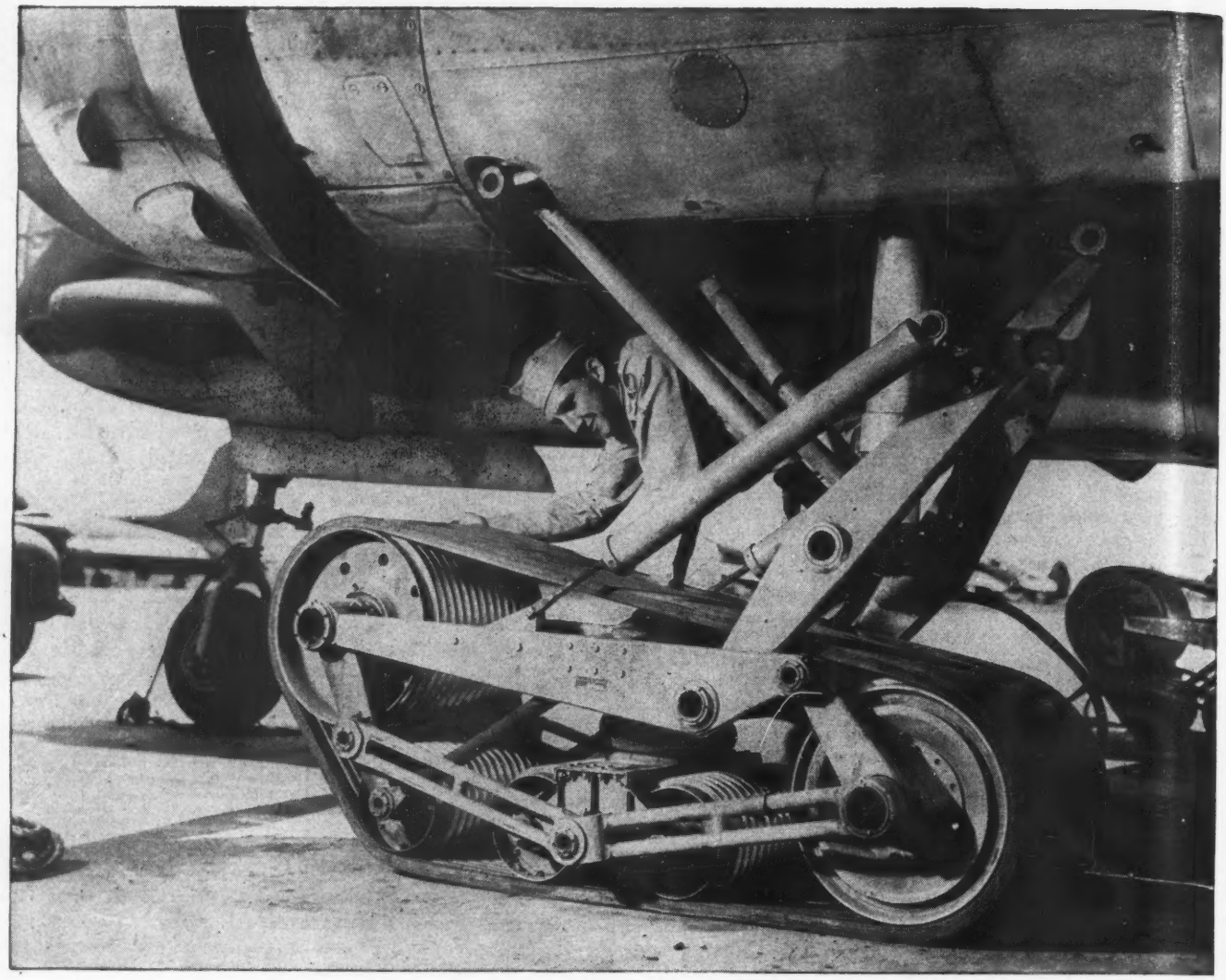
(*Turn to page* 251)

TABLE II—Earnings, Dividends Paid, and Price Range Of Eight Major Aviation Companies' Common Shares, 1938-1943

(Sources: Moody's Industrial Manual for 1943 *and company reports, also Wall Street Journal)*

	1938	1939	1940	1941	1942	1943
Bendix *a*						
Earned per share	$0.07	$2.14	$3.09	$6.30	$5.90	*e*
Dividends paid per share	....	1.50	1.75	3.75	4.00	3.00
Price range — high	30¼	33¾	36¾	41¼	39¼	39¼
low	8¾	16¾	24½	32¾	28¼	33
Boeing						
Earned per share	*d* 0.77	*d* 4.55	0.35	5.65	4.84	*e*
Dividends paid per share	....	....	....	....	1.00	2.00
Price range — high	35¼	34¾	28¾	24¾	21¼	21¼
low	19	16¾	12¾	12¾	13	11¾
Curtiss-Wright						
Earned per share	0.17	0.39	1.81	3.15	1.45	*e*
Dividends paid per share	....	....	.50	1.00	1.00	.75
Price range — high	7¾	13¼	11¾	10¼	9¼	9¾
low	3¼	4¼	6¼	6¼	5¼	5½
Douglas *b*						
Earned per share	3.76	4.81	18.05	30.29	18.42	*e*
Dividends paid per share	3.00	3.00	5.00	5.00	5.00	5.00
Price range — high	80¾	87¾	94¾	79¼	70¾	73½
low	31	55	65¼	59½	51	44
Martin						
Earned per share	2.15	3.75	4.94	5.24	6.01	*e*
Dividends paid per share	....	1.00	2.00	3.00	1.50	3.00
Price range — high	37¾	45¾	47¾	32½	26¼	24
low	14¼	26½	26¾	20½	17¼	14¼
North American *c*						
Earned per share	0.55	2.06	2.06	1.77	3.04	*e*
Dividends paid per share	0.40	1.40	1.25	0.75	1.25	2.00
Price range — high	20	29¼	26¾	17¾	14	14¼
low	5¼	12¾	15	10½	9¼	8
Sperry						
Earned per share	2.46	2.71	3.90	4.11	2.87	*e*
Dividends paid per share	1.60	2.00	2.00	2.00	1.50	1.50
Price range — high	49¾	51¾	47	39¾	31¾	35½
low	15¾	36	33	27¼	21¼	23½
United Aircraft						
Earned per share	2.12	3.53	4.94	6.29	5.95	*e*
Dividends paid per share	1.25	2.00	3.50	4.00	3.00	3.00
Price range — high	43¼	51	53¾	44¾	36¾	40
low	19¾	31	31½	28¾	23¼	24¼

a Years 1938 and 1939, ending Dec. 31; 1940 to 1943 incl., ending Sept. 30.
b Years ending Nov. 30.
c Years 1938 to 1940 incl., ending Dec. 31; 1941, nine months to Sept. 30; 1942 and 1943, years ending Sept. 30.
d Deficit.
e Not available.



Easy does it . . .

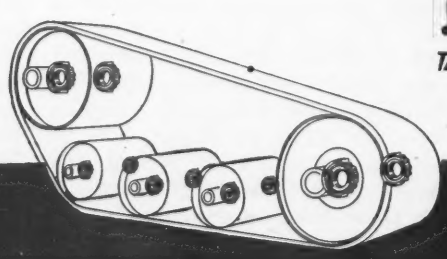
Easy on the runways and landing strips; easy on the pilot's and crew's nerves when landing on soft ground, rough terrain or deep sand - - these are the advantages of this new type landing gear developed by The Firestone Tire and Rubber Company in cooperation with the Army Aircraft Laboratory and the Dowty Equipment Company. With the area of ground contact four to eight times that of regulation landing tires, planes equipped with this gear have landed at 120 miles per hour!

What about bearings? The adverse operating conditions are there; heavy loads, shock and high speeds together with the necessity for the highest degree of dependability. What bearings were selected for this newest innovation in landing gear? Timken Tapered Roller Bearings, of course. The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF

TAPERED ROLLER BEARINGS



JET PROPULSION From Fancy to Fact

Part II

By **WILLY LEY,** *Formerly Vice-President, German Rocket Society*

Reaction-principle contributions of the post-1918 pioneers—down to and including the successful Whittle-Bell-G.E. development—are considered by the author in this final installment of his timely series.

THE EFFICIENCY of the rockets in the various experiments described in Part I of this article (January AVIATION) was less than 1 percent, although the rockets themselves were of good make and quality.

This does not constitute an indictment of rocket propulsion in general but only of plans for operations based on assumptions of energy losses of 99 percent and more. The reason for the magnitude of these losses becomes clear if it is realized that the problem of the efficiency of a rocket motor must be treated in another manner than that of a steam or internal combustion engine. In a rocket motor one always deals with two different percentages—the "inner" or "thermal" and the "outer" or "ballistic" efficiency.

The inner or thermal efficiency may be compared directly with that of an internal combustion engine. While it is very low—around 2 percent—in small fireworks rockets it is respectable, in the case of larger ones (about 20 percent) and unusually high (about 60 percent) in the case of liquid fuel rocket motors. This high efficiency can be explained by these facts: The combustion temperature is high, there are no moving parts, and the friction of the gas stream is low.

The outer or ballistic efficiency, however, depends solely on the speed with which the rocket is moving. If the rocket is "nailed down" it is simply zero, if the velocity of the rocket equals that of the exhaust it is 100 percent. (Theoretically, if the rocket moves faster than its exhaust, the ballistic efficiency may seem to surpass 100 percent, which is, of course, impossible. Actually the rocket, before it does attain such velocity, has to move slower than its own exhaust velocity for quite some time so that the whole performance remains far below 100 percent.)

Even assuming that the outer efficiency soon approaches 100 percent, the over-all efficiency would equal only the figure for the inner efficiency. Since the exhaust velocities vary from around 700 per second for fireworks rockets to over 2,000 m. per second for liquid fuel rockets, it becomes obvious that the ballistic efficiency, and with it the over-all efficiency, has to be very poor indeed unless the rocket is permitted to move with a velocity above 800 mph. at the very least.

This was realized by some inventors more than 20 yr. ago, and the obvious conclusion was that either the speed of the airplanes had to be increased (in a then incredible manner) or else the velocity of the exhaust had to be reduced very considerably. The latter seemed easier to achieve since it could be done simply by adding mass, i.e., air, to the exhaust so that the mass of the exhaust would be increased with a proportional reduction of velocity.

In 1917, O. Morize of Châteaudun, France, proposed a power plant which was to achieve this goal. Morize's idea was production of a rocket blast by means of an engine-driven compressor, fuel injection pumps, and combustion chamber with exhaust nozzle, also to surround the exhaust nozzle with a

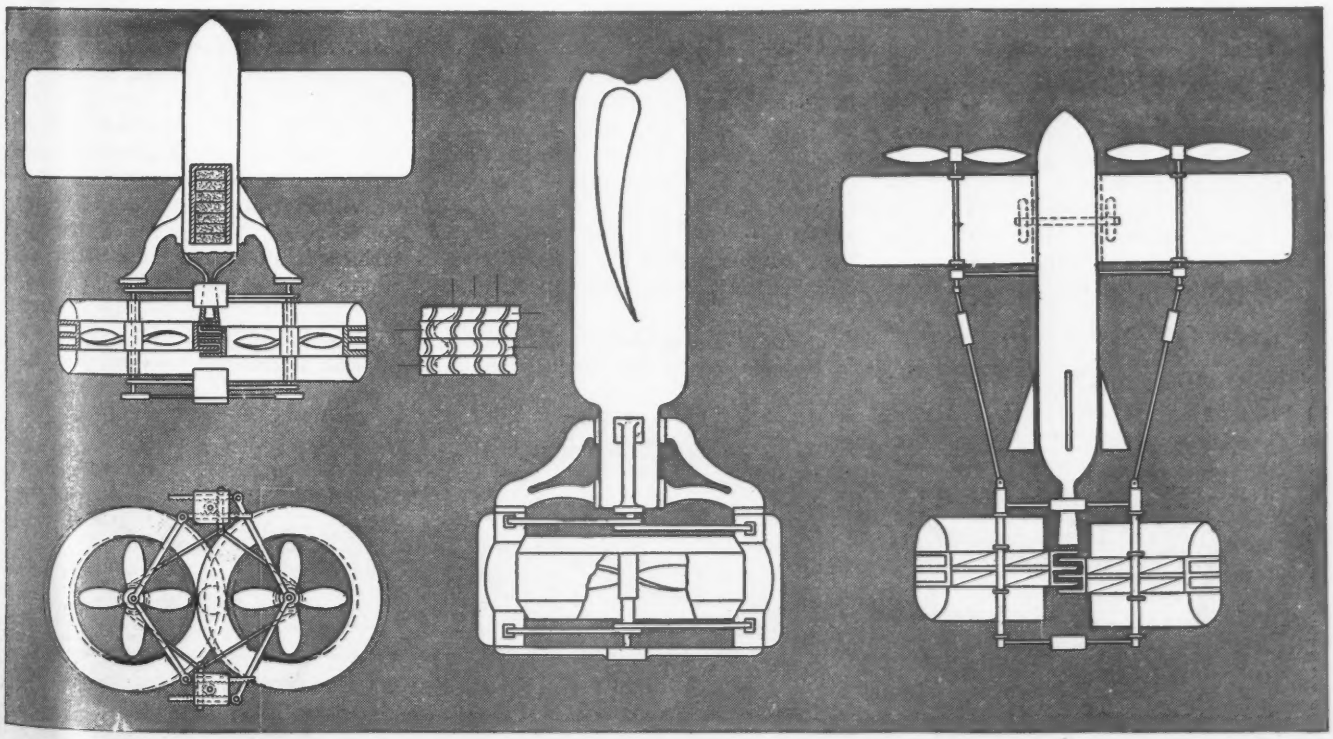


Fig. 1. Goddard's project used jet-driven propellers at low altitudes, then relied solely upon jets as higher levels were reached.

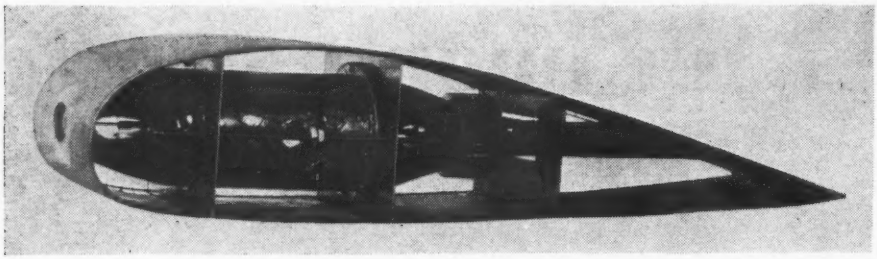
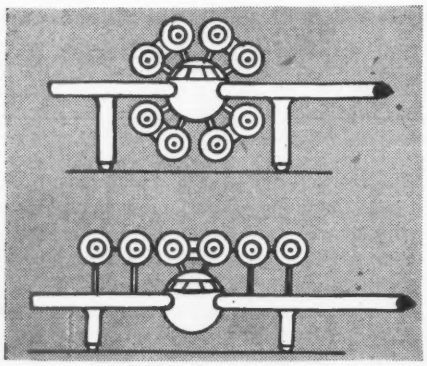


Fig. 2. Goldau employed combustion chambers in which speed of exhaust gases was controllable by fuel regulation. Pictured is experimental model in airfoil section.



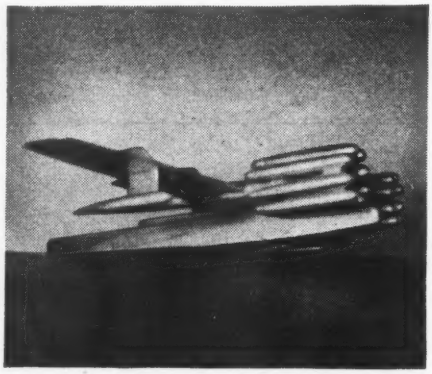


Fig. 3 (left). Possible arrangements of Goldau's twin reaction chambers. **Fig. 3a** (right). Flying boat model equipped with Goldau chambers.

series of venturi nozzles to add large amounts of outer air. This device has later received the name of thrust augmentor and has been the subject of quite a number of experiments and discussions, among them several NACA reports.

But Morize did not build it then. This was left to his compatriot, Henri F. Mélot, who used an invention of his own to produce the rocket blast. It consisted of two cylinders, placed end to end, with fuel inlet ports and spark plugs at either end. An unconnected piston was placed inside for compression, and the exhaust gases were led to a common chamber to which the exhaust nozzle was attached. The device was hard to start, but once started (by means of compressed air) it ran nicely, producing an intermittent blast. Mélot first experimented during the period from 1918 to 1920, then again resumed experimentation some years later. But it seems that he never progressed far beyond his original accomplishment.

While not actually successful, the Morize-Mélot scheme of adapting the otherwise inefficient rocket blast to aviation gave rise to a number of other projects.

One of them is the combination turbine and direct reaction plane patented by Dr. Robert H. Goddard in 1929. (U. S. Patent No. 1,809,271 of June 9, 1931, filed June 28, 1929). The leading idea of this project was to insert two turbine wheels, with propellers mounted inside, into the rocket blast for the takeoff and for flight in the dense atmosphere of low altitudes. Once high altitudes and high speeds were attained the rocket was to act directly.

The mechanical embodiment of this idea, as it was then published, is shown in Fig. 1. The rocket motor is located in the tail end of the device, with the propellers mounted inside the turbine wheels. The shafts of the latter are hinged so that the turbine wheels can be removed from the blast by a slight lateral turn of the hinged shafts. It is obvious that this design is most unlikely to perform in reality. In the first place most of the heavy parts are massed in the extreme tail end, and the fuel tanks could hardly be used for balancing the heavy tail, especially since the weight of the fuel tanks would diminish very rapidly.

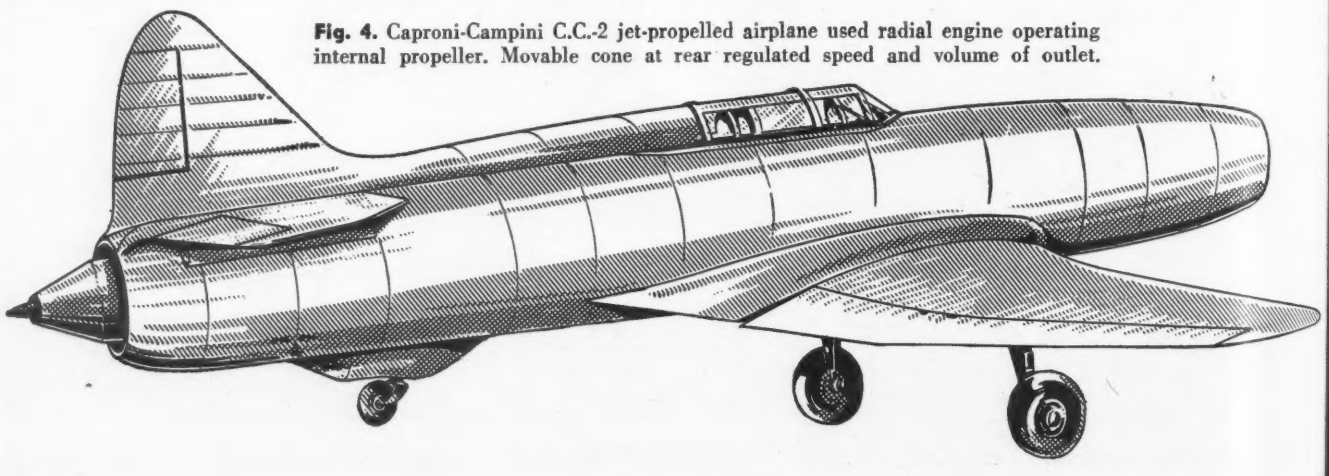
Other engineering problems—for example a suitable material for the turbine rings which have to withstand the heat of the rocket blast—present additional obstacles, even if the device could carry enough fuel for successful operation under these conditions, which seems exceedingly doubtful.

Another project, in which the leading idea is again the addition of atmospheric air to the rocket blast, rests on two German patents, No. 544,834, valid beginning Oct. 21st, 1930, and No. 596,856, valid beginning Feb. 25, 1932, both granted to Wilhelm Goldau of Duisburg-Meiderich.

Goldau's method, which he demonstrated with a number of small functioning models, differs from Mélot's insofar as the atmospheric air is not added to the rocket blast after the generation of the latter, but rather before combustion. Goldau planned very large reaction chambers, working in pairs. At least three such pairs would be required to propel a plane. They could be arranged around the fuselage in various patterns or might also be placed in the wings (Figs. 2, 3, and 3a).

Goldau's long torpedo-shaped reaction chambers are fitted with a valve at either end. At the beginning of each cycle both valves are open so that the air can flow through the entire length. Then a small amount of benzene, which ignites very rapidly, is sprayed into the

Fig. 4. Caproni-Campini C.C.-2 jet-propelled airplane used radial engine operating internal propeller. Movable cone at rear regulated speed and volume of outlet.



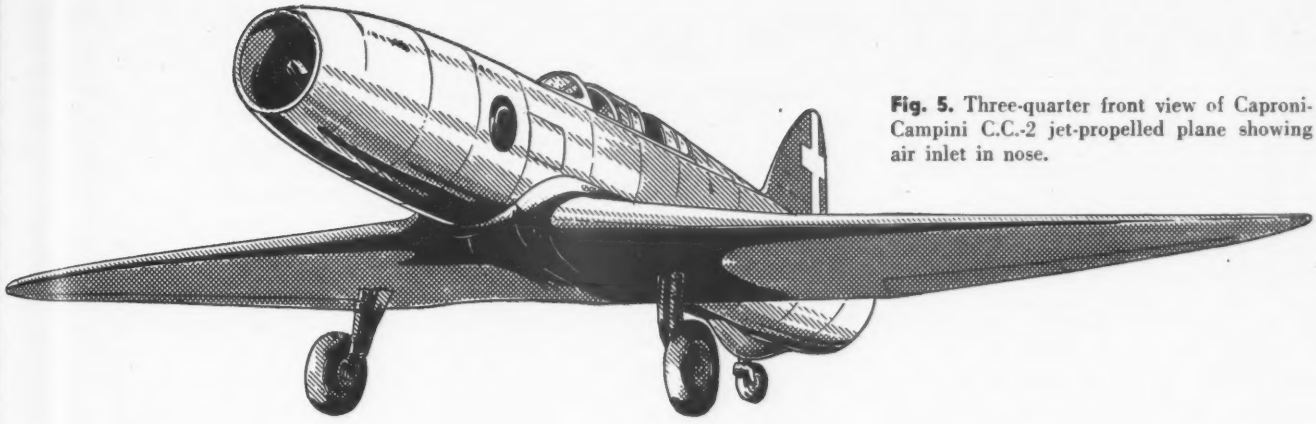


Fig. 5. Three-quarter front view of Caproni-Campini C.C.-2 jet-propelled plane showing air inlet in nose.

chamber. The exhaust valve is then closed, simultaneously with the fuel injection valve. Then the mixture of fuel vapor and air is ignited, with simultaneous opening of the exhaust valve. While the latter is still open the intake valve is opened again and the next cycle begins.

It is important that the pressure developed does not exceed 50 psi., hence the chamber can be light. Air cooling is sufficient, not only because of the large surface of the chamber but also because the air intermittently flows through the chamber, displacing residual combustion gases. The cycles of the two chambers that form a pair augment each other in such a way that the suction produced by the exhaust of the one draws air into the other. The exhaust speed can easily be regulated by metering the fuel and can be reduced to a few hundred meters per second so that the plane can soon attain a velocity near that of its exhaust.

If political conditions in Germany had not prevented Goldau from continuing his work he might have succeeded in building such a craft in 1936 or 1937. Actually, the first jet-propelled plane, as is well-known, was not of the Goldau type but of the type invented by an Italian, Secondo Campini, whose craft was finally built by the firm of Caproni. The first of these jet-propelled planes, the C.C.-1, was test-flown by Col. de Bernardi in Aug. 1940 near Milan. It took off by means of a propeller, then switched to jet propulsion in mid-air. This model weighed around 8800 lb. The C.C.-2 (Figs. 4 and 5) built later, weighed about 11,000 lb., had a retractable undercarriage, dispensed with the propeller, and was a two-seater. It is to be noted that the C.C.-2 differed considerably from an early patent obtained by Caproni Aircraft in France in 1932.

The C.C.-2 was a low-wing instead of a high-wing monoplane, with the cabin perched on top instead of being placed in the nose. The C.C.-2 flew 168 mi. (from Milan to Rome) attaining a speed of 130 mph. The flight took 2 hr. 20 min. counting in an intermediate landing near Pisa, probably for refueling.

Compared with Goldau's design, the interior of the C.C.-2 was enormously complicated. It consisted of a blower driven by a radial engine which sucked air through the open nose of the fuselage. Then the air was condensed, fuel injected into it, and the fuel ignited. The exhaust consisted of the combustion products plus the exhaust from the radial engine.

In spite of the voluminous justification of his system published by Campini (translated as *Tech. Memo No. 1010* by the NACA) one may wonder whether that radial engine, if used to drive a propeller, would not have given a higher speed and a longer range to the plane. Goldau's design is justified by its simplicity, whereas the Caproni-Campini design appears to be unnecessarily complex and especially vulnerable to criticism based on the rocket theory in general.

A jet of which atmospheric air is an important component contradicts its own purpose to a large extent. If the jet is to be superior to the very efficient engine-propeller combination it can be only for flight in altitudes where propellers do not work well or for flights of a velocity that propeller driven airplanes cannot attain because of reduced propeller efficiency at very high rotative speeds.

Naturally these two things go together to a large extent, since such high speeds cannot possibly be achieved in layers of high atmospheric density. The jet-propelled plane, therefore, cannot expect to compete with the propeller driven airplane for speeds of less than 400 mph. Jet craft should be faster, which implies higher altitudes with thinner air.

For competition at lower altitudes the Caproni-Campini is unsuited because its complicated mechanism occupies the whole fuselage so that designers have some trouble finding room for the pilot's cabin.

But there exists another possibility for indirect jet propulsion at low altitudes—the jet helicopter, a helicopter with a rotor which is propelled by the reaction of a jet of some kind. Those who consider this a new idea will be surprised to learn that the first helicopter *model* that actually flew was of the jet-propelled type. It was, in fact, nothing but the old aeolipile of classic antiquity, whirling around and around by steam reaction in the manner of a rotating lawn sprinkler fitted with helicopter blades. This steam-reaction model helicopter was successfully demonstrated at Paris by one "Engineer Phillips" in 1842. It rose to a considerable altitude and covered a distance of almost half a mile. And it resulted in the then apparently inevitable cartoon mocking its possibilities (Fig. 6).

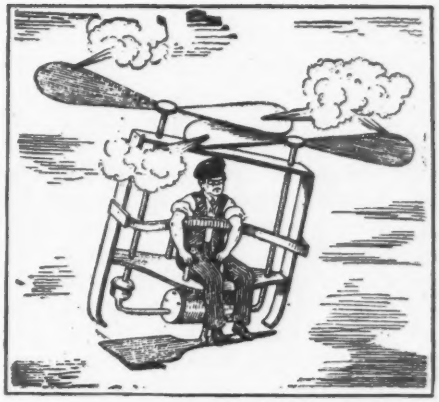


Fig. 6. Cartoon of reaction helicopter (about 1855). Phillips built a demonstration model about that time. With steam overhead and a boiler beneath him, pilot's heating problem was automatically taken care of, hence rolled sleeves.

The idea was again brought up in 1911 by a German inventor, Wilhelm Gaedicke, who under the nom-de-plume of "Eng. Crassus" published a small book, *Der gefahr-lose Menschenflug* (Human Flight Without Danger). His project (Fig. 7) consisted of a multi-bladed helicopter with a cabin hanging from it. The rotor was to be turned by the reaction of jets of burning illuminating gas while the horizontal move-

ment was to be accomplished by a single small exhaust nozzle in the rear of the cabin. His contention was that such a helicopter would attain a speed of 20 mph. A second nozzle might be used to increase the speed, he added after clearly stating that he personally failed to see a reason for higher speeds.

"Crassus" Gaedicke was only one of many inventors who advocated reaction-driven propellers or helicopter rotors. The idea of a reaction-helicopter is justified theoretically because of the fact that the blade-tip speed of the rotor is rather high, even if the helicopter itself is hovering. The blade tip speed may easily surpass 1,000 ft. per second, which is high enough to make a jet efficient.

The difficulties in this case would be difficulties of design. If the jet generator (whatever that might be) is located in the fuselage it would require a hollow rotor shaft and hollow blades, and there would be the trouble of keeping all connections leak-proof. If the jet generator should be small and light enough to be rotated along with the rotor, most design difficulties would disappear. It is difficult to judge this problem on a general basis without specific suggestions. But even so it can be said that the difficulties appear to be mainly of the nature of problems of design, instead of fundamentals.

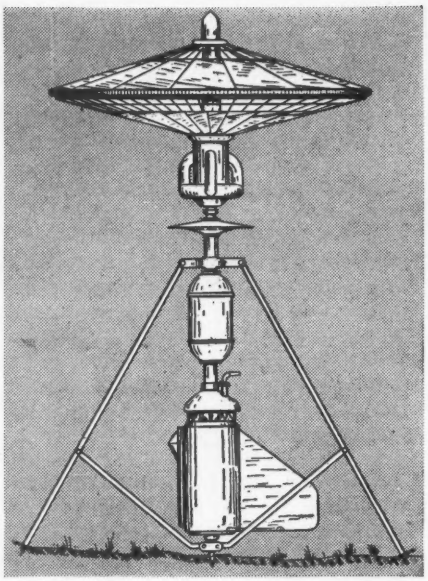


Fig. 7. In 1911 this reaction-driven helicopter was invented by Wilhelm Gaedicke. It did not get beyond the design stage.

We have seen that the direct reaction plane suffers mainly from the fact that the difference between flying speed and exhaust velocity is too large for efficient propulsion. The modified reaction or jet propulsion plane does not fare much better, for other reasons: The equipment required to work the modifications usually eliminates the theoretical advantages of rocket propulsion, and this tends to lead to schemes which of necessity defy themselves.

Let us now condense a number of theoretical surveys of the problem of the direct reaction airplane made by Dr. Eugen Sänger in his book *Raketenflugtechnik* and, somewhat later, in a paper which occupied an entire special issue of the Viennese aviation magazine *Flug* (Dec. 1934, translated as NACA *Tech. Mem. No. 1012*, Apr. 1942).

Dr. Sänger began his work with a long series of actual experiments conducted with the facilities of the University of Vienna in 1931 and 1932. His rocket motors were spherical, made of steel, and fueled with a light fuel oil and liquid or gaseous oxygen under very high pressures. Dr. Sänger achieved a constant recoil of around 55 lb. for periods from 15 to 25 min.

Experimental evidence, as well as theoretical considerations, made it clear that sustained propulsion in the manner of the engine-propeller combination cannot be expected of rocket motors. The whole performance would hinge on the problem of attaining a very high speed—and with it a high altitude—as quickly as possible for the sake of efficiency, and also the problem of converting the resulting high speed into range.

Keeping these conditions in mind, Dr. Sänger arrived at the following conclusions: The plane should take off under an angle of about 30 deg. and climb under that angle until the desired high altitude has been attained. Then the craft should level off. After two or three minutes of level flight, the fuel supply would be exhausted, but the plane would go on, slowly losing speed as well as altitude, until time to land. The figures for a typical flight would be: Burning time of the rocket motor 20 min.; total duration of the flight, slightly more than 1 hr., and average speed, 1,600 mph. The probable appearance of such a plane is shown in Fig. 8.

In general, Dr. Sänger came to the decision that for a given payload the fuel expenditure for a certain range would be about the same for such rocket airplanes and for conventional airplanes, the only gain being time.

Somewhat later (Jan. 1936) Dr. Sänger published a paper on auxiliary rocket motors for propeller airplanes in the *Schweizerische Bau-Zeitung* (Vol. 107, No. 2). Here he assumed that a large rocket motor (Fig. 9.) would deliver 1 ton of thrust for a period of 90 sec., and that it could be installed in a pursuit plane weighing normally 3,740

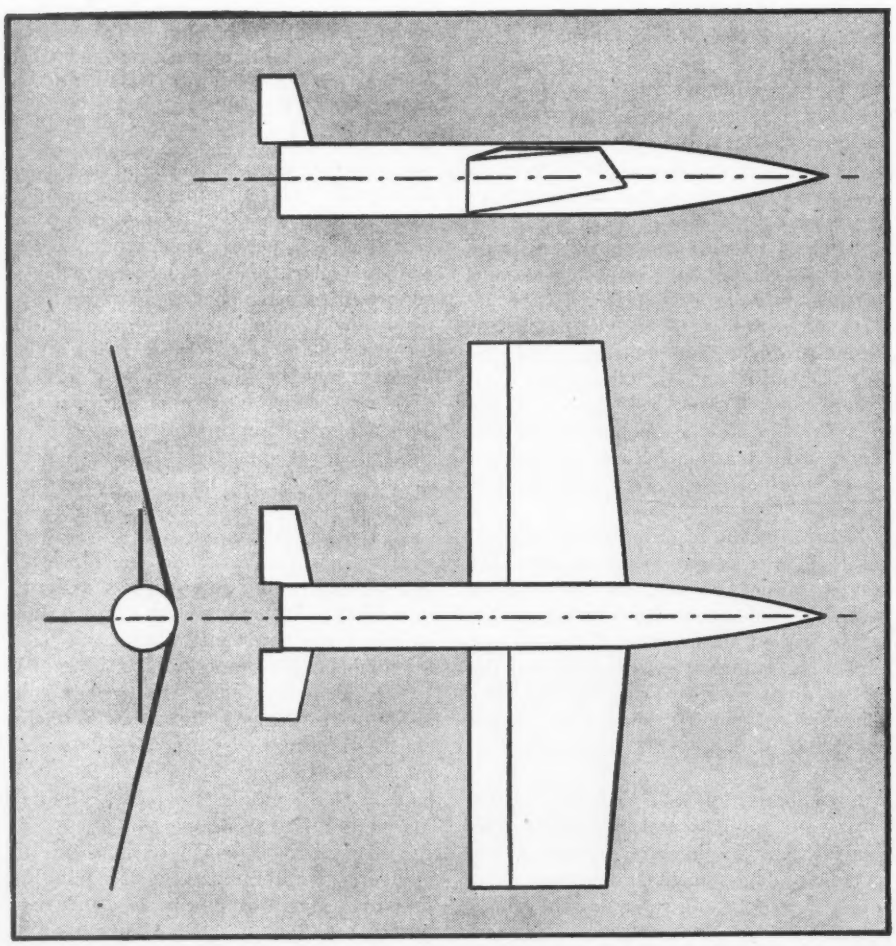


Fig. 8. Dr. Sänger's sketch of probable appearance of a single-seat jet-propelled stratoplane.

lb. and capable of attaining a maximum speed of 320 mph. Such a plane conventionally would need 8 min. to climb to an altitude of 20,000 ft., but with a rocket motor of 1 ton of thrust, the same plane could climb to 20,000 ft. in 86 sec.

The climb, assumed to be made at the advantageous angle of 30 deg., would be accomplished by the rocket motor alone, while the propeller would only furnish the power required to overcome air resistance. This may also be expressed by saying that the engine-propeller would work as if the plane were in a horizontal flight at top speed, while the rocket lifted it.

The whole rocket apparatus would not be too large to fit into such a plane. It would consist of three spherical tanks—one for liquid oxygen, one for fuel oil, and the third for compressed nitrogen, the latter used to force the two liquids into the combustion chamber. The outside diameter of the oxygen tank would be about 30 in., the o.d.'s of the other two tanks about 2 ft. each. Further, valve of assembly would be rather small, with the rocket motor itself of about 7 in. dia. and roughly twice as long. This motor would be in the extreme tail end (see Fig. 10). The weights were calculated as shown in accompanying Table I.

Being equipped with such a device, the plane would weigh 4,700 lb. (instead of 3,740) with a resulting increase in takeoff speed of about 12 percent. The gain would be 6 or 6½ min. of time for a climb to 20,000 ft., the disadvantage a dead weight about 200 lb.

That a 1-ton-thrust motor could be built after some experimentation is hardly subject to doubt, but it would be difficult to decide whether the 6 or 6½ min. gain for the climb would count more than the final dead weight of 200 lb., or vice versa. It seems, however, that the experts of the *Luftwaffe* decided the handicap would be greater than the gain, because they have obviously failed to make use of Dr. Sänger's theoretical groundwork, although they had it available ever since its publication.

Table I—Calculated weights for Dr. Sänger's Proposed Auxiliary Rocket Device for Takeoff Climb

(Assumed performance: 1 ton of thrust for 90 sec.)

Fuel tank with valves, empty	22	lb.
Oxygen tank with valves, empty	45	
Nitrogen tank with valves, empty	115	
Rocket motor and fuel lines	23	
Total rocket assembly	205	lb.
Fuel (oil)	165	lb.
Liquid oxygen	510	
Compressed nitrogen	70	
Total fuel	745	lb.
Grand Total	950	lb.

It seems, in retrospect, as if the Germans instead of doing experimental work along these lines, waited to see what would happen with the Caproni-

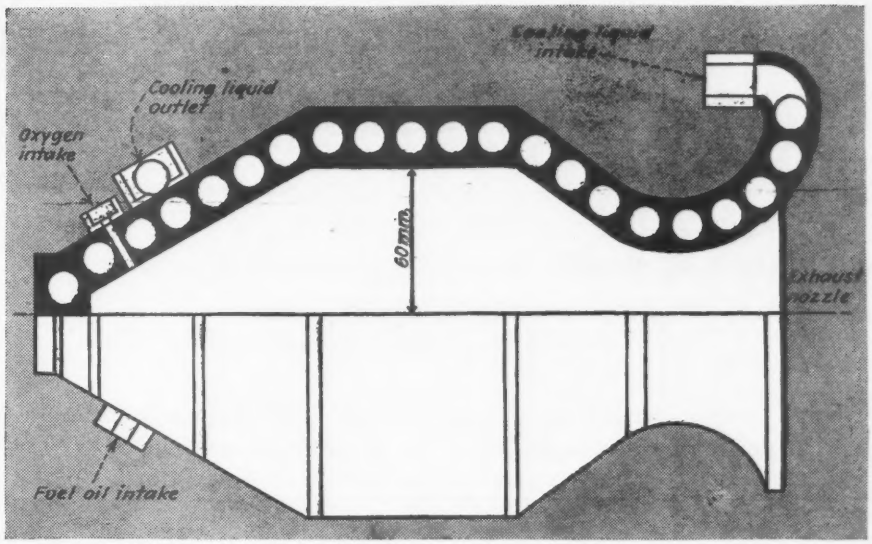


Fig. 9. Liquid-cooled rocket motor with thrust of about 1 ton. Dr. Sänger proposed its installation in a pursuit plane to afford super climbing speeds.

Campini jet-propelled type. This was a mistake, for not only did the performance of the Campini plane fail to amount to anything, but the Axis, as became known early last month, was neatly scooped by the British.

At the time the C.C.-2 limped from Milan to Rome in Dec. 1941, the British jet-propelled plane, originated by Capt. Frank Whittle, had already made its first successful flight (May 1941), while the first successful run of the engine had been made in complete secrecy as early as 1937. It has been reported that Capt. Whittle conceived the idea of his jet-propelled plane in 1933, that the secret was made known to Gen. Arnold five months prior to Pearl Harbor, and that the engine with which the first flight had been accomplished was shipped to the United States in Sept. 1941.

The first American jet craft by Bell Aircraft Co. is reported to have had two engines, presumably looking like a twin-engined plane, and the British model is said to resemble the P-38 Lockheed *Lightning* in external appearance. It has not been disclosed whether the British craft has one or two jet engines (though similarity to the P-38 implies two) but it has been stated that the type of engine it employs consists of a blower coupled with an internal combustion turbine which burns kerosene.

The plane emits a loud whistling sound when in flight. In fact the reason for releasing the secret was that many people had seen the plane during test flights and guessed from the sound that it must be a new type. The "Squirt", as British spectators were quick to call the craft, is said to be especially suitable for flight at high altitudes, and observers have stated that it is so fast "that it makes *Spitfires* seem slow".

The well known British air expert, Maj. Oliver Stewart, admitted during a radio interview that the Whittle plane has the disadvantage of having an extremely high fuel consumption.

There can be no doubt that the new jet types are far superior to the Campini plane. Still, peacetime applications await further experiments.

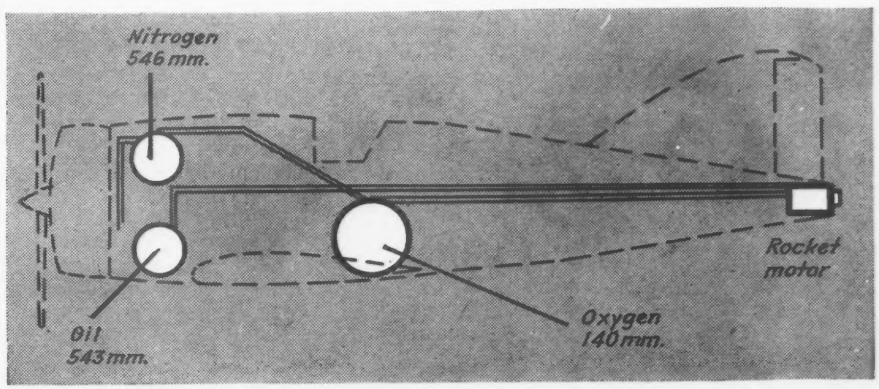


Fig. 10. Fighter plane design by Dr. Sänger including takeoff rocket motor to assist in rapid climb.

Pressure Control In Aircraft Hydraulic Systems*

Part II

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Principal unloading valves are described, with diagrams explaining their action and advantages . . . Concluding article.

WHEN RELIEF VALVES control the pressure in a hydraulic system by relieving excess pressure, as discussed previously, energy is transformed into heat. As a result, the fluid soon becomes very hot and in a short time it would destroy many critical parts of the hydraulic system. Therefore, relief valves can be used only for a short time and in an emergency.

Pressure in the hydraulic system is controlled by a pressure regulator, sometimes known as an unloader valve. This valve has two distinct functions: 1. to maintain the required pressure in an accumulator, and thus the hydraulic system, within a set range; 2. to completely unload and by-pass the fluid from the pump back to the reservoir with a minimum loss in pressure.

Generally, the valve is mounted on the firewall of the engine nacelle in a line between the pump and accumulator. In operations, when the pressure in the accumulator reaches the upper limit for which the regulator is adjusted, a valve opens automatically and the output of the pump is by-passed back to the reservoir. This is called unloading. At the same time, a check valve prevents back flow or loss of pressure from the system.

When the pressure drops to the lower limit (usually 150 to 200 psi.), either by pressure losses in the system or by the opening of a selector valve, the by-pass valve in the unit automatically closes and the pressure from the pump is directed into the accumulator and the system.

During flight, when the hydraulic system is not doing useful work, it is necessary that the time interval of loading and unloading should be at least half an hour. In the event of internal leakage in the hydraulic system or the unloader valve, this period would be seriously shortened, so the accumulator must be large enough to compensate for the leakage during this time.

For correct operation, it is obvious that the pressure regulator valve must load and unload at exactly the pressures for which it is adjusted, with the result that governed operating pressures may always and instantly be available as soon as any of the selector valves are opened and the pressure from the pump is made available to the chosen mechanism.

* Opinions and representations in this series are the authors' and should not be construed as reflecting Bureau of Aeronautics views.

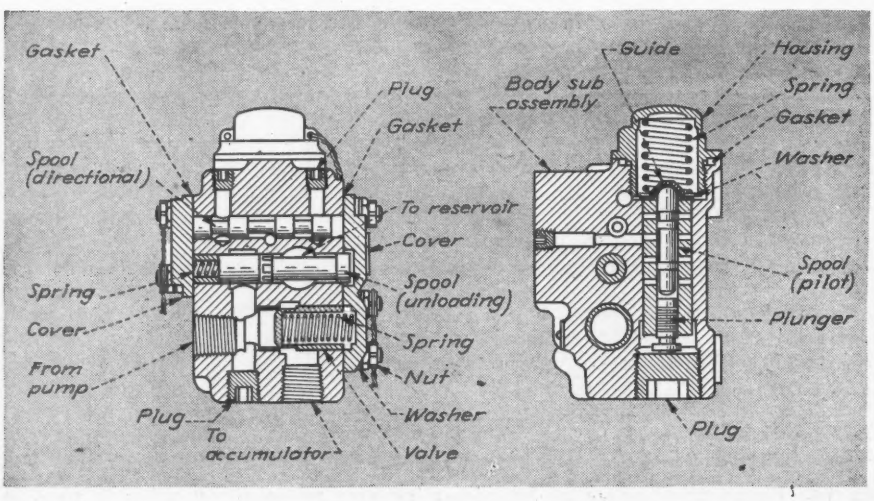

Fig. 7. Vickers pressure regulator.

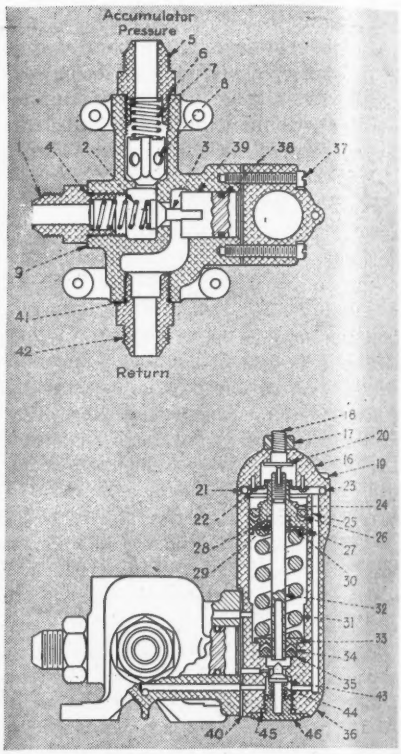

Fig. 8. Bendix pressure regulator; cross section.

Although the operation is very much the same, the designs and internal construction of the pressure regulators differ radically.

The pressure regulator illustrated in Fig. 7 (made by Vickers, Inc., of Detroit) has been used extensively by the aircraft industry for many years. The valve consists of an aluminum alloy housing in which are fitted three closely fitted slide valves or spools and a poppet type check valve. Suitable porting between the slide valves provides flow for pressure regulation, while the check valve prevents back flow from the system while the valve is unloading. The valve is provided with three port connections: Pump pressure inlet, system and accumulator outlet, and by-pass to reservoir.

A schematic layout is shown in Fig. 9, where four positions are depicted:

Position No. 1 represents the static condition with no pressure in the accumulator and hydraulic system. In this condition, valves *2* and *3* are held in the positions shown by their springs. No

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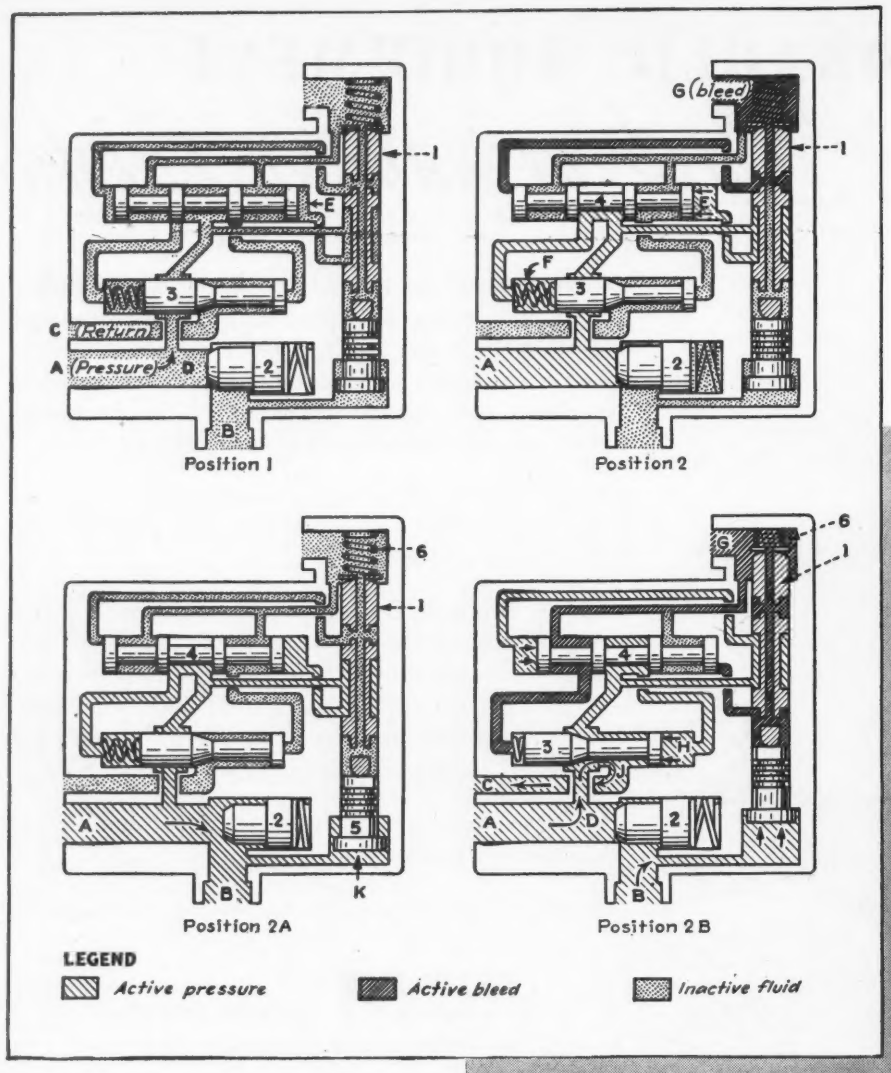
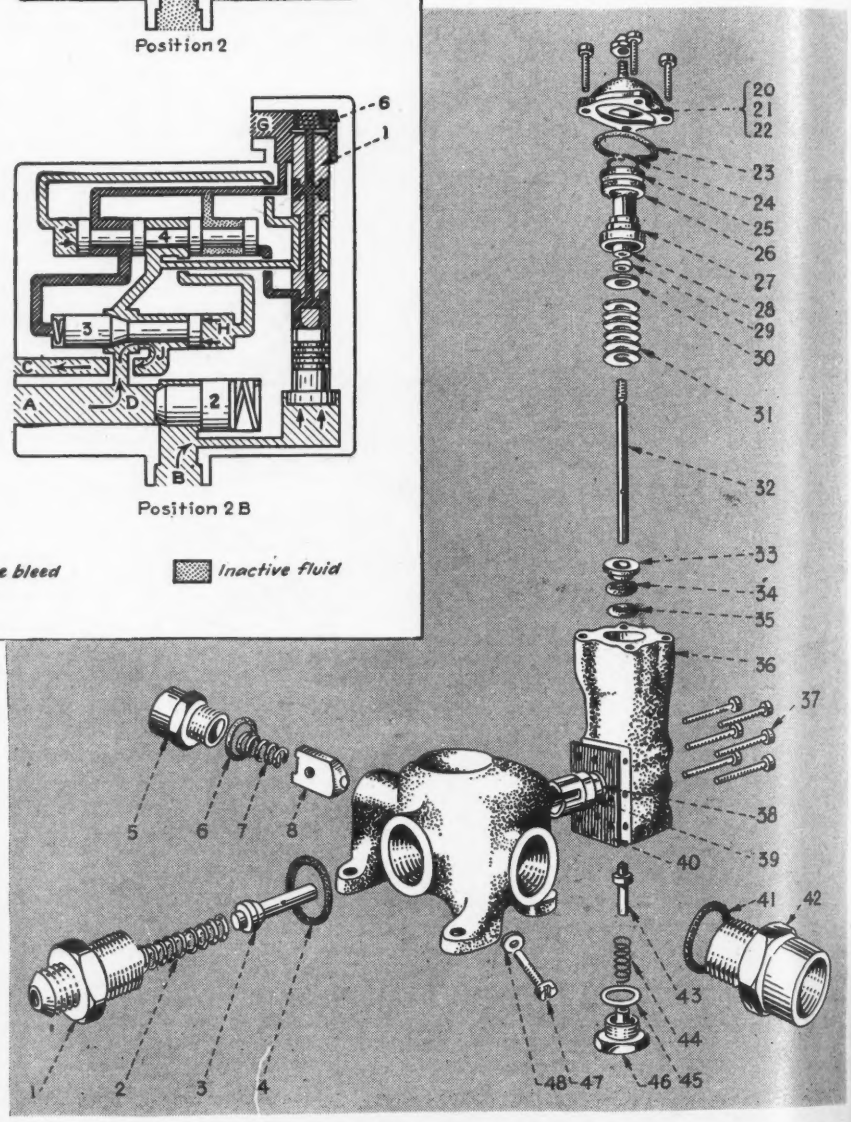


Fig. 9. Schematic diagram of four positions of Vickers pressure regulator.

Fig. 10. Exploded view of Bendix pressure regulator.



flow from intake port *A* to accumulator port *B* or return to reservoir port *C* can take place. The first pressure to enter at *A* will travel through *D*, around valve *3* by way of an annular groove, and through passages to *E*.

Position No. 2. Five pounds pressure at *E* moves spool *4* to the left, as shown, building pressure in space *F* behind valve *3*. Fluid at the left end of spool *4* bleeds off through passages to outlet *G*. Valve *2* is still held on its seat by spring.

Position No. 2A. As fluid pressure continues to rise, valve *2* is lifted off its seat and the charging of the accumulator begins through outlet *B*. As the pressure from *A* through *B* reaches the top setting of the valve, a restricted orifice conducts this pressure to chamber *K*. At this pressure, plunger *5* and pilot spool *1* overcome the pressure of spring *6* and move upward, as indicated in position No. 2B.

Position No. 2B. Raised position of pilot spool *1* routes fluid pressure to the left end of spool *4*, moving it to the right as shown, and supplies a bleed passage from the right end of *4* up through the center of spool *1* to bleed line *G*, while position of spool *4* permits pressure to flow from *A* to *H* and valve *3* is forced to the left against spring measure. As valve *3* is forced to the left, it connects by-pass *D*, through *J*, to return line *C*, and the regulator unloads. As valve *3* is moved to the left, a bleed is permitted from its left end through passages to *G*.

As the pressures in *A, D, H, J* and *C* are now equalized, valve *3* is held in right-hand position by pressure at *H*. Any tendency for the spring to move valve *3* to the right would slightly restrict flow to tank, thereby increasing pressure on right-hand end of by-pass valve to maintain required opening. As pump delivery is by-passed from *A* to *C*, with a minimum pressure drop, valve *2* is again seated by its spring, preventing back-flow from accumulator. Pilot spool *1* is held in "up" position by pressure from accumulator until that pressure drops to low limit, when spring *6* pushes pilot spool *1* down, when the fluid is again re-routed, returning valves

(*Turn to page* 133)

The B.F. Goodrich Airplane of the month

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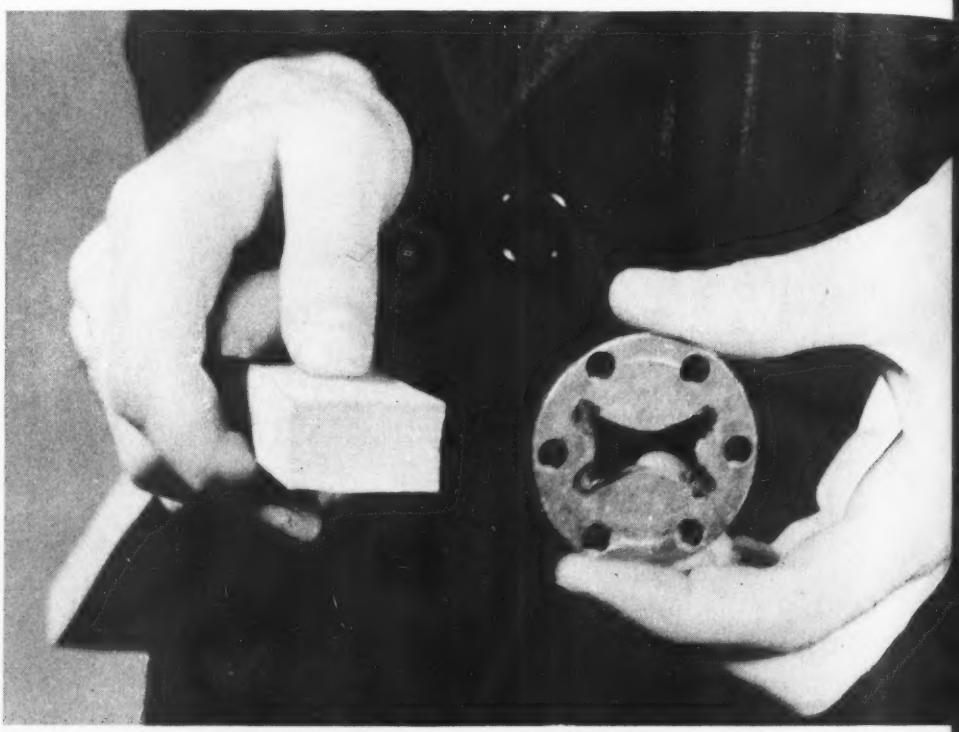

• *One of the many sponge sealing strips and the precision die with which it was processed.*

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ONE GUN TURRET leaked when it rained until a special sealing strip was developed that provided a dependable, practical seal. The odd shape of the seal was engineered by men at B. F. Goodrich who have been solving problems like it for dozens of aeronautical applications.

Rubber, whether natural or synthetic, is pressed through precision dies, and this process is known as "extruding." Shaping and designing these dies requires careful engineering planning due to the peculiar flow characteristics of the rubbers used. Some of the dies, and the extruded strips that come from them, are shown on the next page.

Although B. F. Goodrich dies already available cover thousands of different shapes, each new application is studied to be sure that the best results are obtained. If a custom-built die is needed, blueprints are made and the special shape is produced.

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The applications of extruded seals are practically unlimited. Doors, windshields, and windows, regardless of size or shape—bomb-bay assemblies—gun turrets and nose turrets. If you have any problem, no matter how complex, that you think might be solved with a rubber ring, tube, strip or packing, address your inquiries to The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

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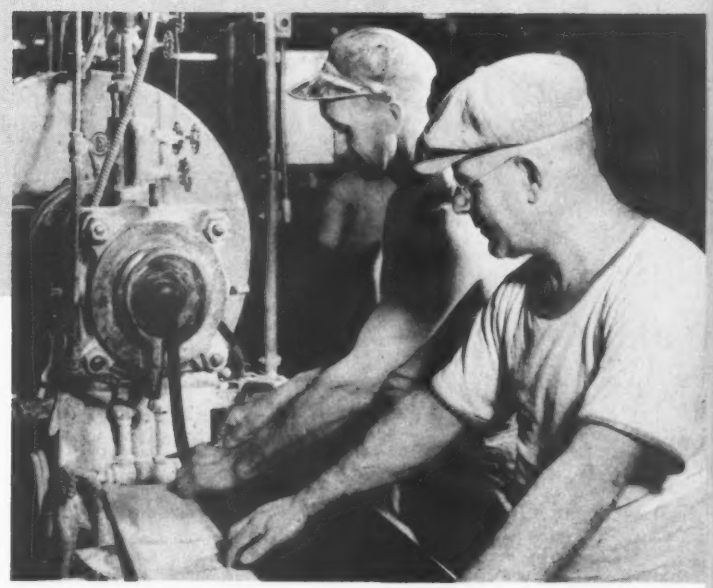

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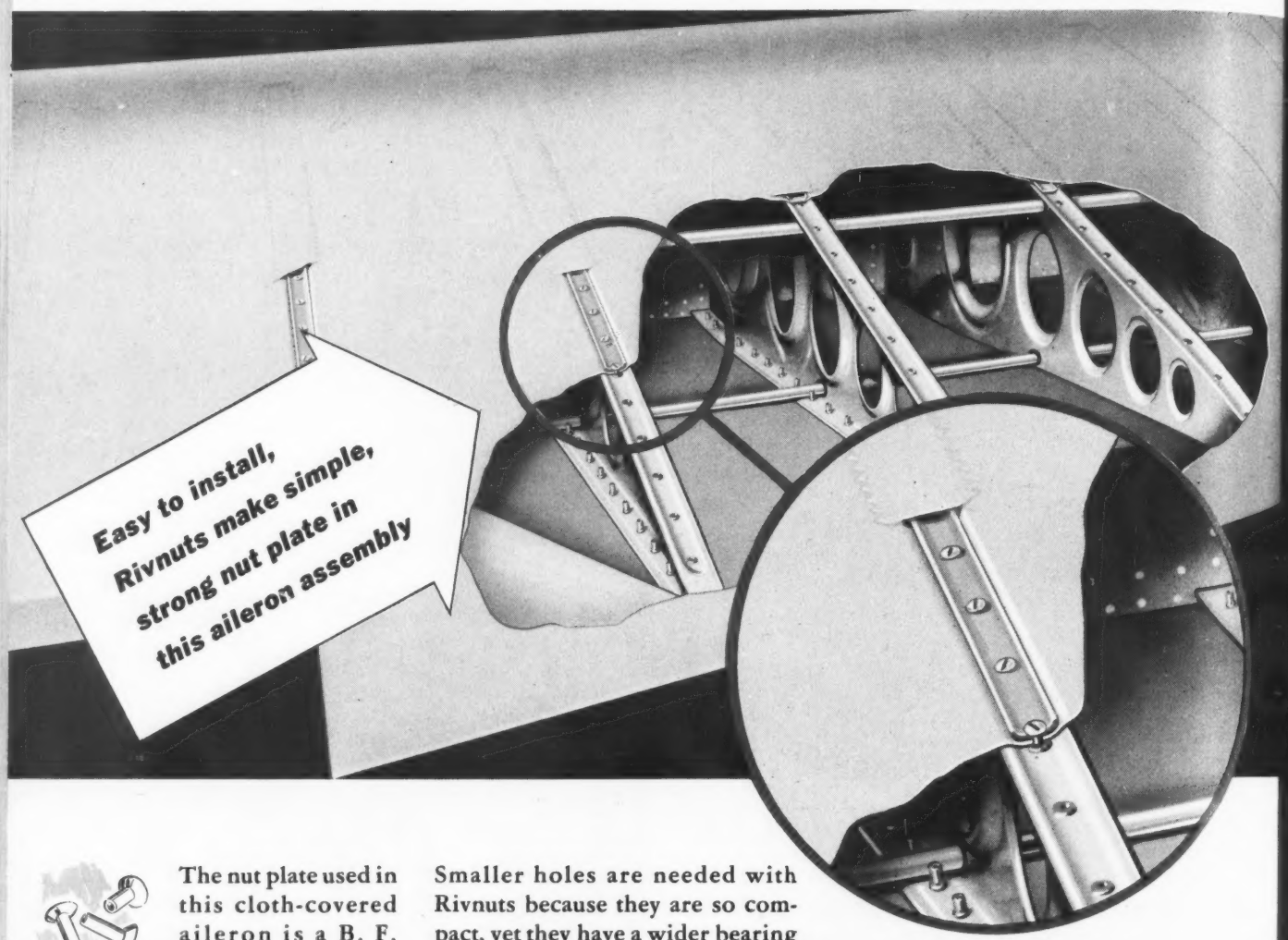

The nut plate used in this cloth-covered aileron is a B. F. Goodrich Rivnut. It's strong and dependable, made of aluminum alloy, saving plenty of weight. The simple, one-piece construction of the Rivnut makes installation so easy that even a green hand can learn to install Rivnuts and become highly proficient in a very short time. And it keeps the cost low, too.

Smaller holes are needed with Rivnuts because they are so compact, yet they have a wider bearing area than any other fasteners of this type. The counterbore and sharp, clean-cut threads make screw insertion easier.

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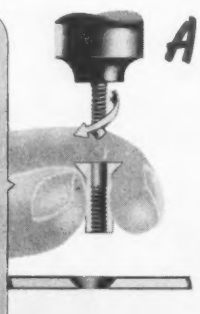
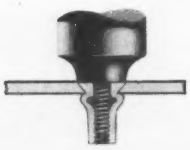
HEADING RIVNUTS IS AS SIMPLE AS A B C

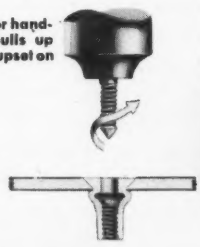


A First step in Rivnut installation (A) thread Rivnut on mandrel of heading tool.

B Next (B) power or hand-operated tool pulls up Rivnut, causing upset on blind side.



C Final step (C) remove tool by disengaging mandrel from upset Rivnut.



In war or peace

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4 and 3 to positions shown in position No. 2 and recommencing the loading operation.

Featuring extreme simplicity in construction and design, the pressure regulator illustrated in Fig. 12 is being supplied to the aircraft industry by Electrol, Inc., of Kingston, N. Y. The rise of steel precision balls in a very clever manner, plus the application of hydraulic balance and differential areas, accounts in large measure for the success of this valve. The Electrol unit is small and light, with use of bar stock for the housing and steel balls for the valves eliminating many production and manufacturing problems. The design and operation of the valve is based on a steel ball floating between two seats of slightly different areas. The difference of these areas determines the rate of regulation or pressure differential between loading and unloading of the pump.

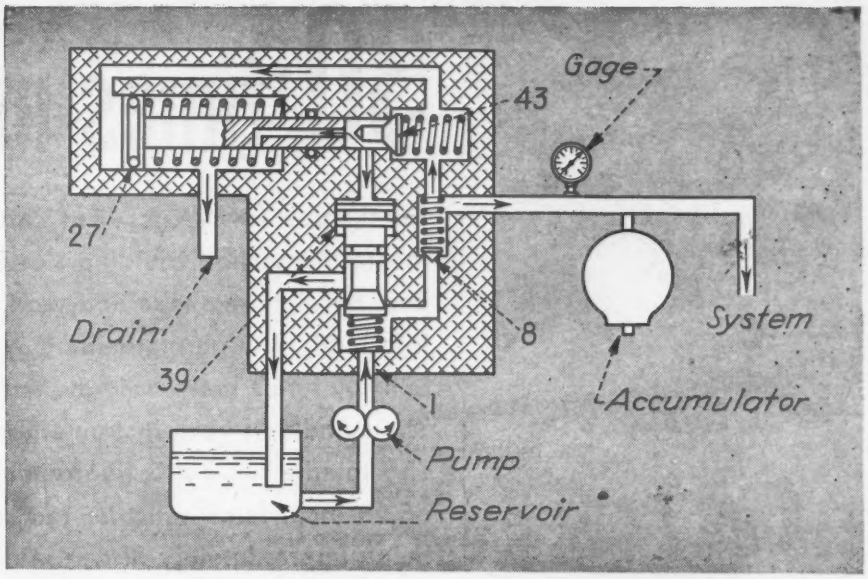


Fig. 11. Schematic diagram of Bendix pressure regulator.

In Fig. 12, it can be seen that the valve consists of an aluminum alloy housing *A* in which there are three bores. In one of these is mounted the check valve and seat *L*; perpendicular to this bore is differential pressure-controlling valve *H* having differential area seats. A spring (operating through a rod and outside adjusted) seats the ball under load. The third bore houses the by-pass valve *E* operated by a plunger under pressure and resisted by a spring. Suitable passages are drilled between the bores to allow interflow for valve operation.

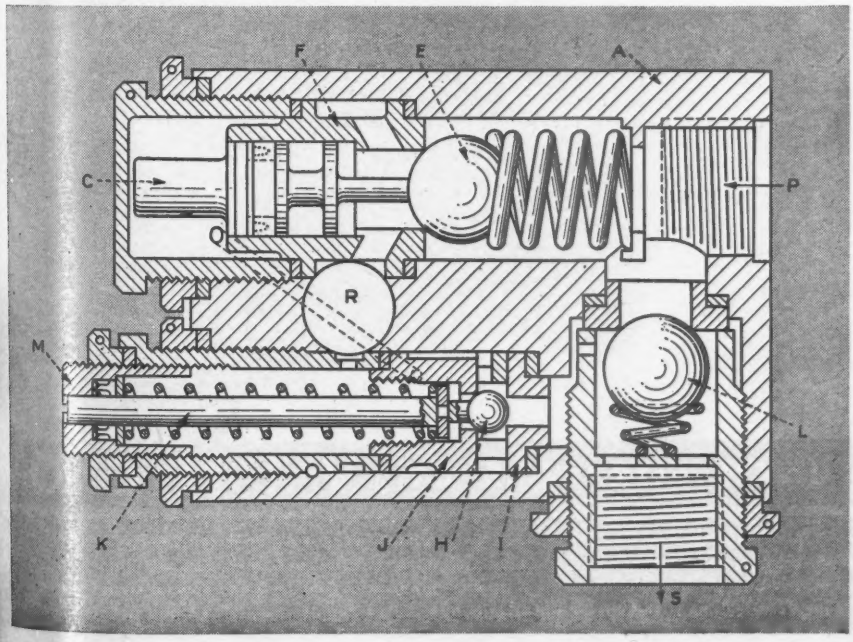
In operation, fluid enters the valve at port *P*, travels through check valve *L*, then goes into the by-pass chamber where it is held by the ball valve *E* at a very slight pressure (2 to 5 psi.). The fluid flows around the check valve, while pressure in the system and the accumulator builds up until it reaches that at which the spring load against the ball is set. At this pressure (that of unloading) ball *H* is lifted off its seat, and due to its small permitted movement it will seal the upper seat The fluid is then directed behind plunger *G*, raising the by-pass valve *E* and allowing fluid from intake port *P* to flow through return port *R* into the reservoir.

Check valve *S* maintains pressure in the system, which holds the ball *H* against the upper seat, thus trapping the fluid in the chamber behind piston *G* and keeping by-pass valve off its seat. When the pressure in the system drops to that for which the differential area between the upper and lower seat of valve *H* is calculated, the spring pushes the ball back to the lower seat, thus cutting off pressure feed to piston *G* and opening this chamber to return, allowing valve *E* to cut off the by-pass flow. Thus the cycle starts again.

An enlarged cut-away view of valve *H* is shown in Fig. 12a. This ball valve *H* is movably positioned between two poppet seats with a very small degree of movement, the left hand controlling the flow of exhaust fluid to return line. The right hand or pressure supply side is slightly smaller than the left seat or exhaust side. Therefore, when the pressure is great enough to lift the poppet ball against the spring load, it will seat against the left seat, where it will be maintained by the pressure differential between the sides of the poppet ball. The action of the ball may be followed by referring to Fig. 12a, with fluid pressure considered as psi., spring pressure as *P*, and area of seat as *A*. The formula of operation will be—

$$\text{Psi} = \frac{P}{A}$$

(*Turn to page* 245)



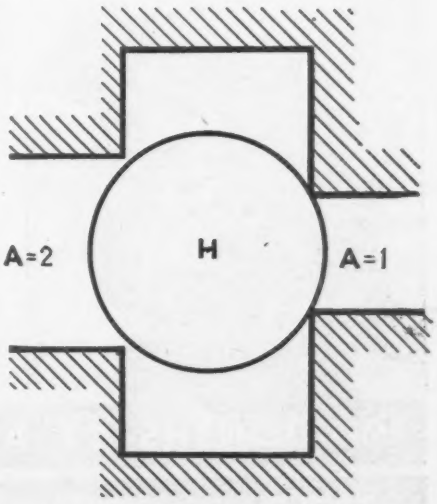
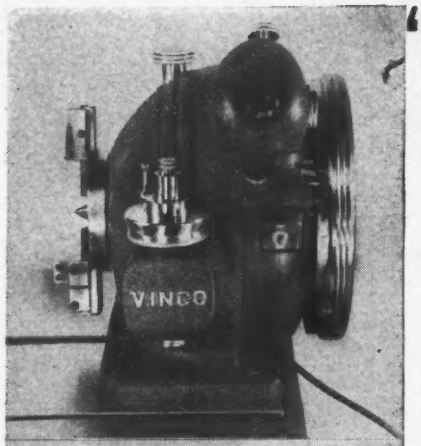
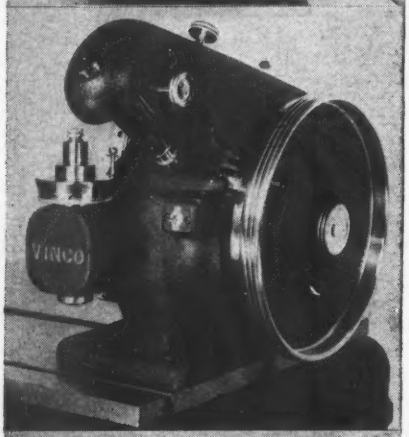


Fig. 12. (left) Electrol pressure regulator, and **Fig. 12a** (above) enlarged cross section of valve shown at H in Fig. 12.





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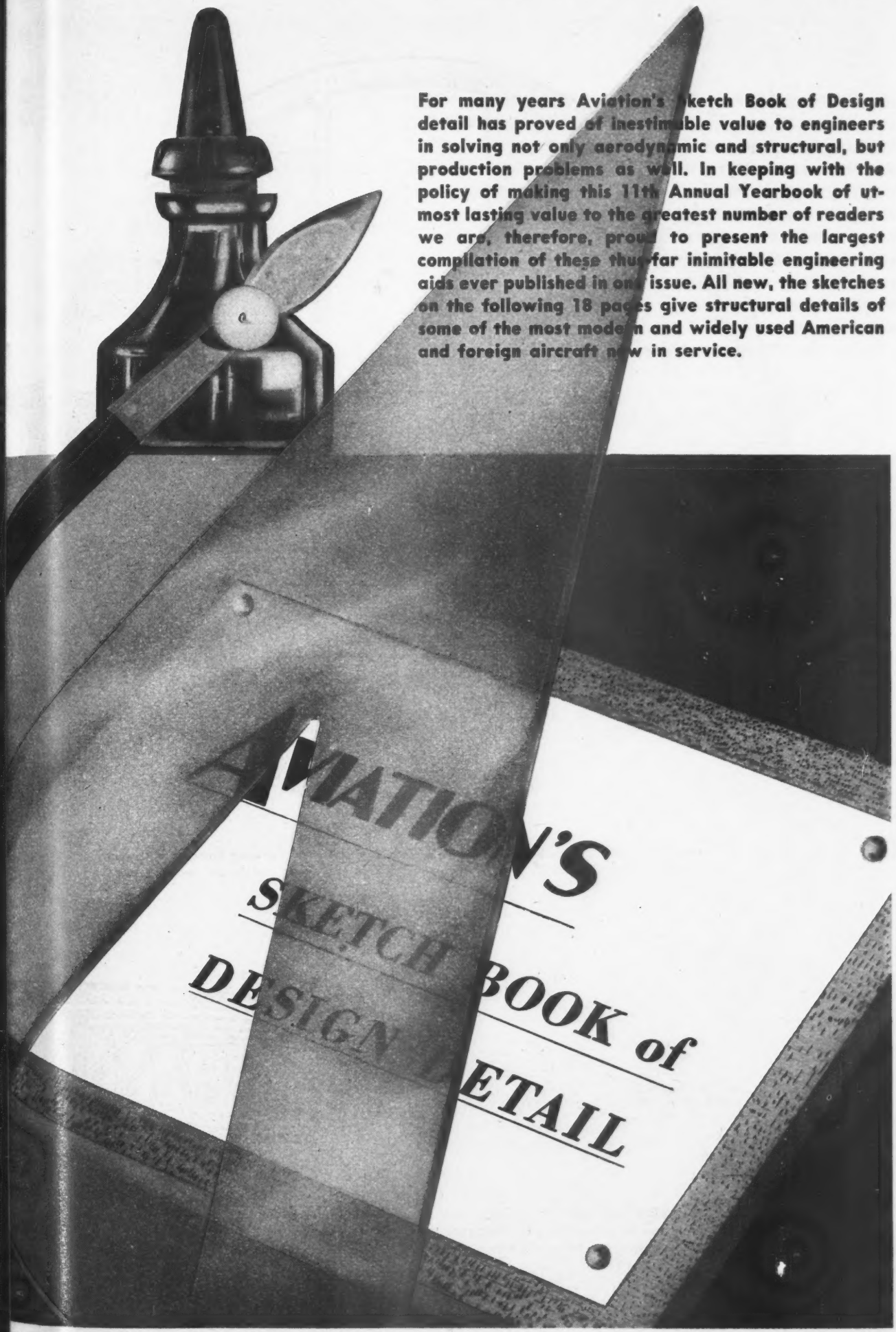

For many years Aviation's Sketch Book of Design detail has proved of inestimable value to engineers in solving not only aerodynamic and structural, but production problems as well. In keeping with the policy of making this 11th Annual Yearbook of utmost lasting value to the greatest number of readers we are, therefore, proud to present the largest compilation of these thus far inimitable engineering aids ever published in one issue. All new, the sketches on the following 18 pages give structural details of some of the most modern and widely used American and foreign aircraft now in service.

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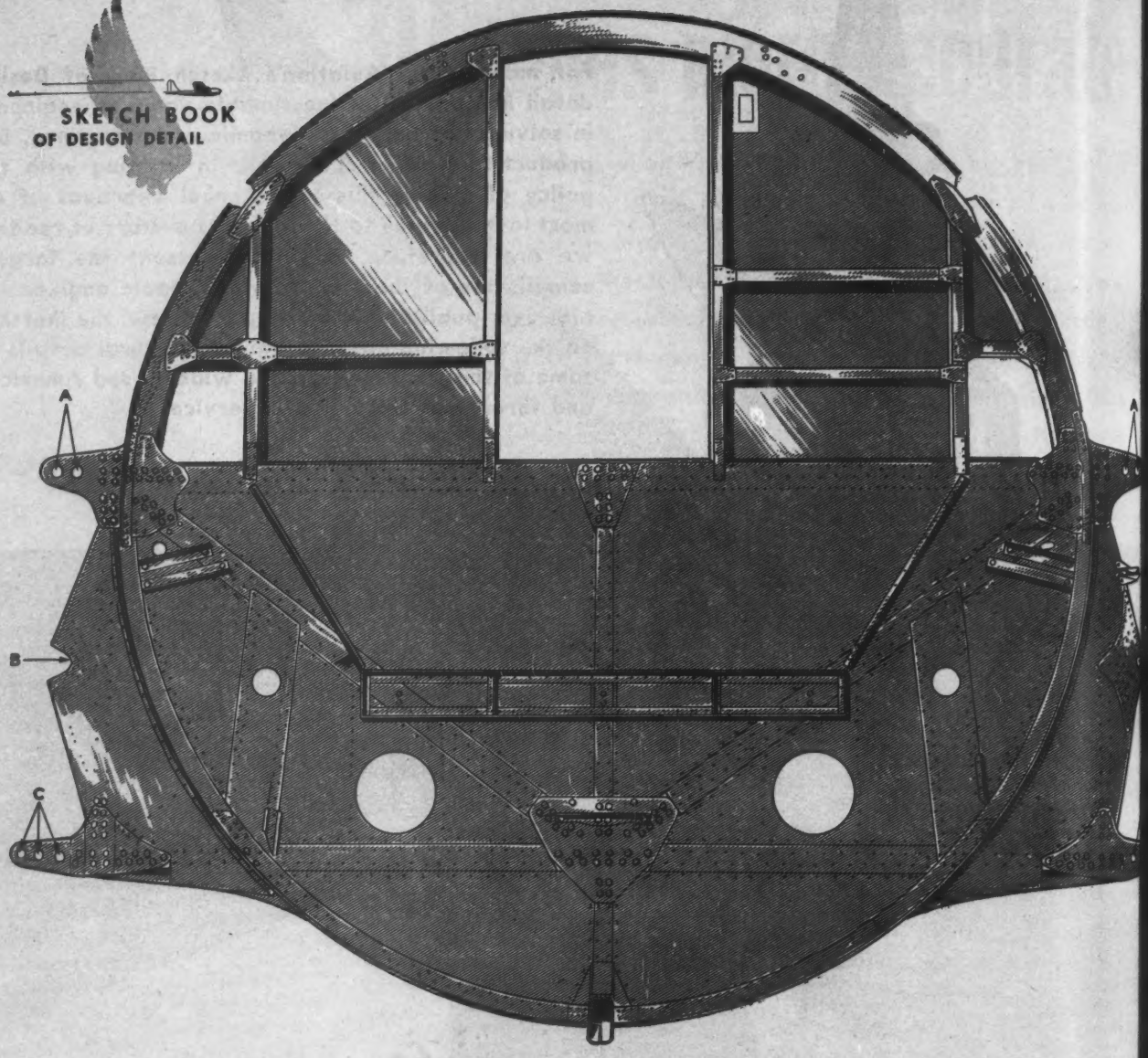
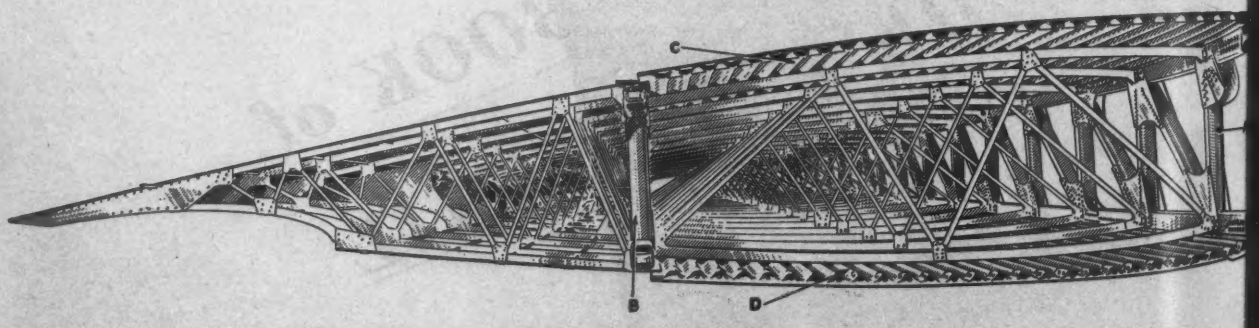
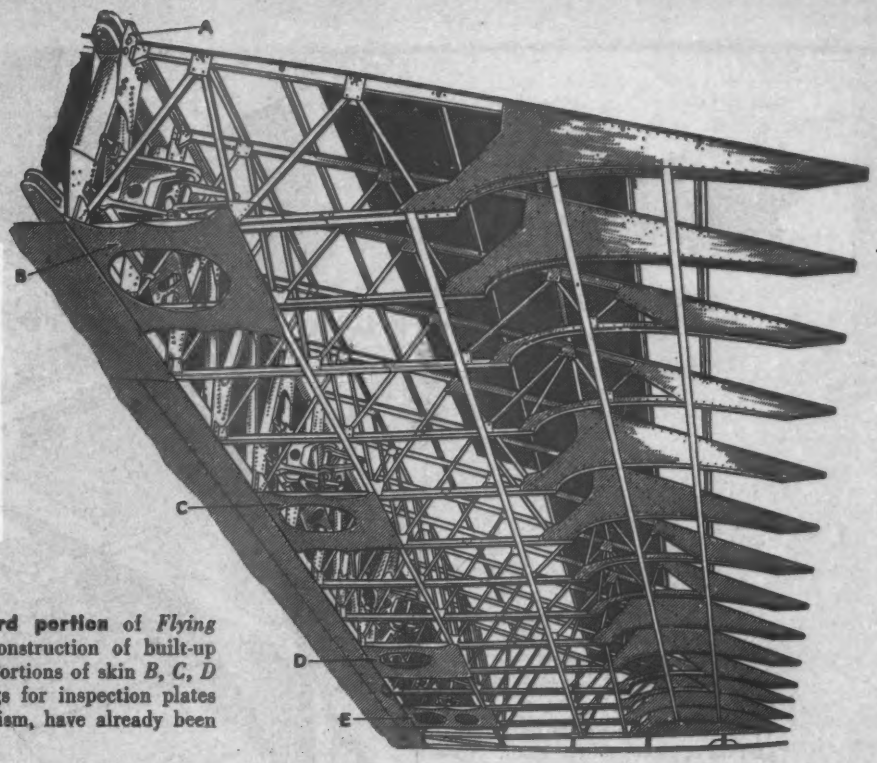


Front view of fuselage bulkhead of Boeing B-17 *Flying Fortress* at wing juncture, with spar attaching points at *A*, *B*, and *C*, details of which are shown below on opposite page.



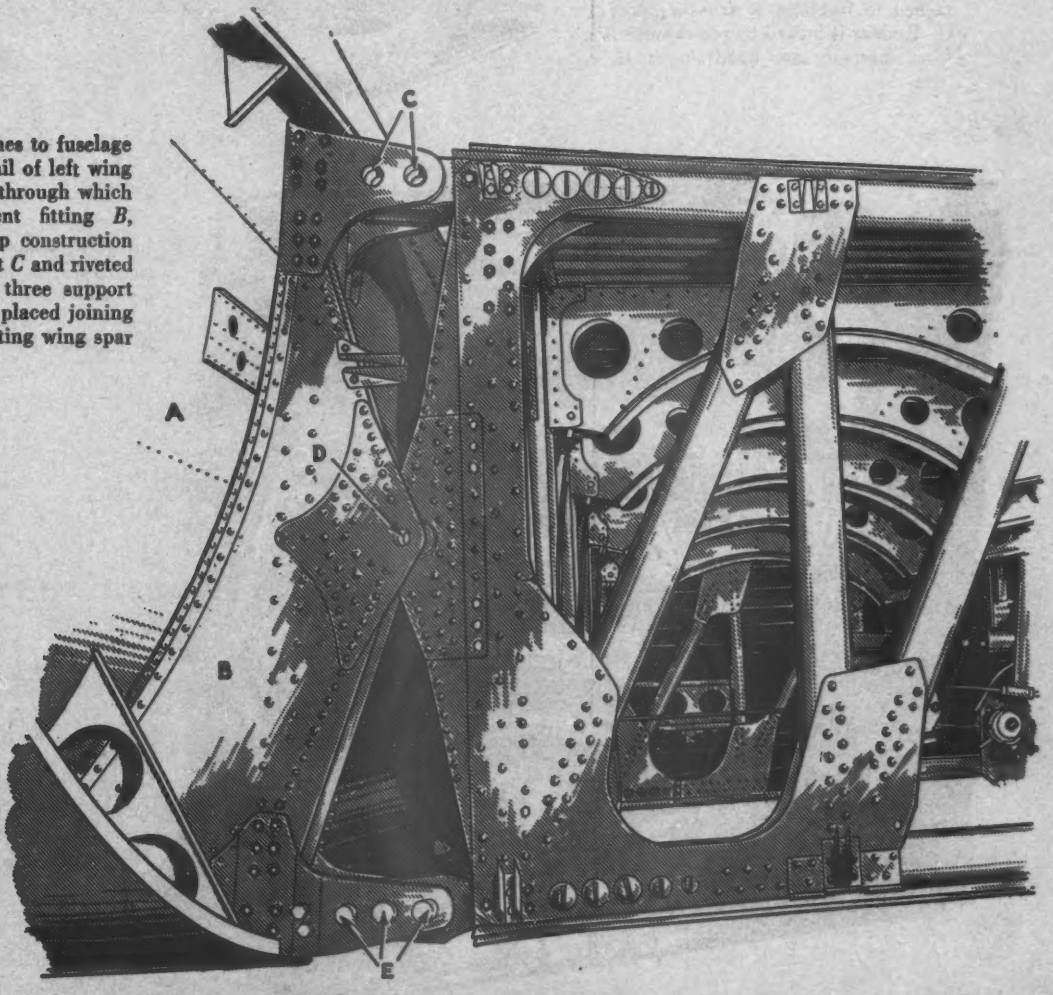
Profile view of B-17 outer wing panel showing built-up truss type front and rear spars *A* and *B*, respectively, together with truss type ribs—both 'tween spars and in trailing edge—and rolled stiffeners employed for both top skin *C* and bottom skin *D*.

Boeing B-17

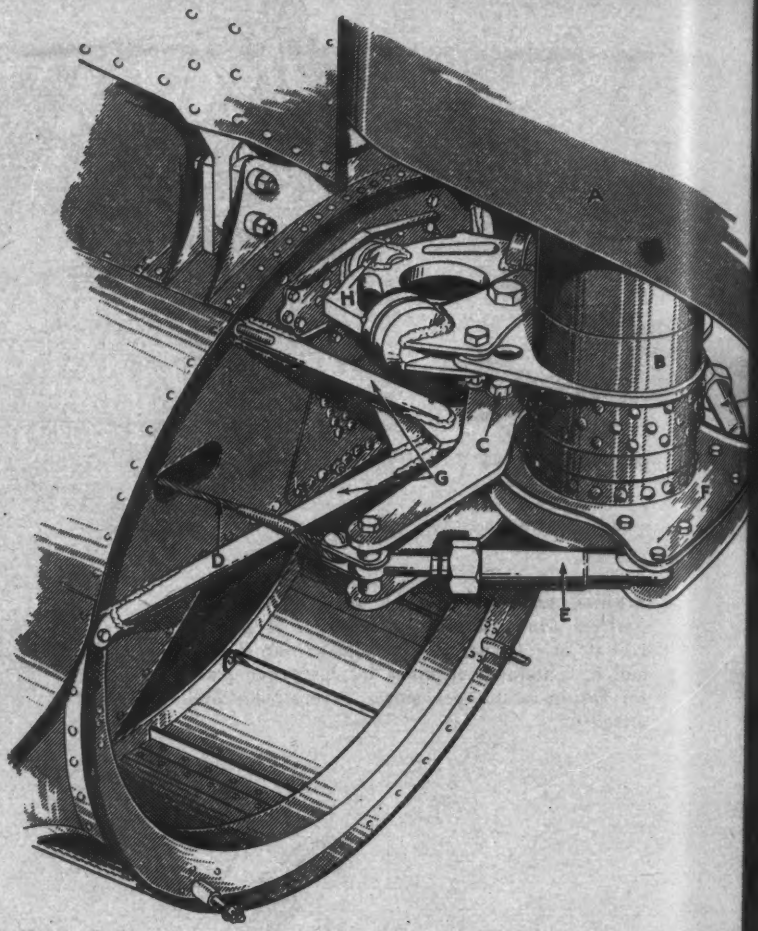


Trailing edge of inboard portion of *Flying Fortress* wing, showing construction of built-up ribs aft of rear spar *A*. Portions of skin *B*, *C*, *D* and *E*, containing openings for inspection plates for flap operating mechanism, have already been attached.

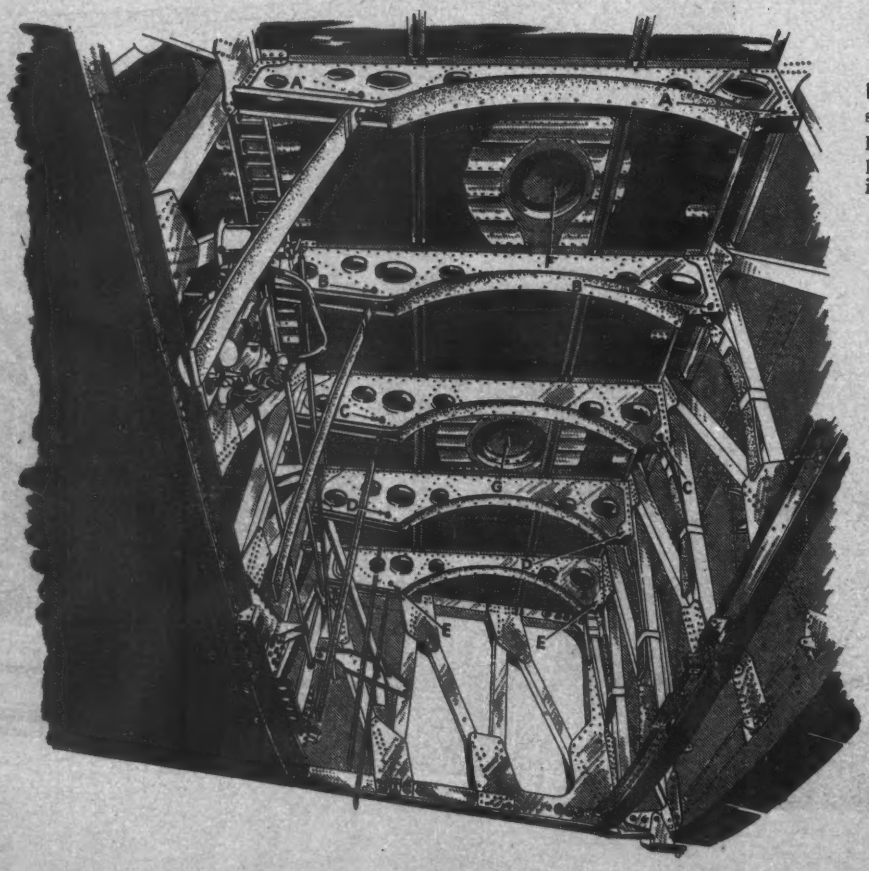
spar of B-17 attaches to fuselage ree points. This detail of left wing part of fuselage *A* through which wingspar attachment fitting *B*, h is partially built-up construction forging at top support *C* and riveted truss *D*. Through three support *E*, through-bolts are placed joining ort brackets with mating wing spar ga.



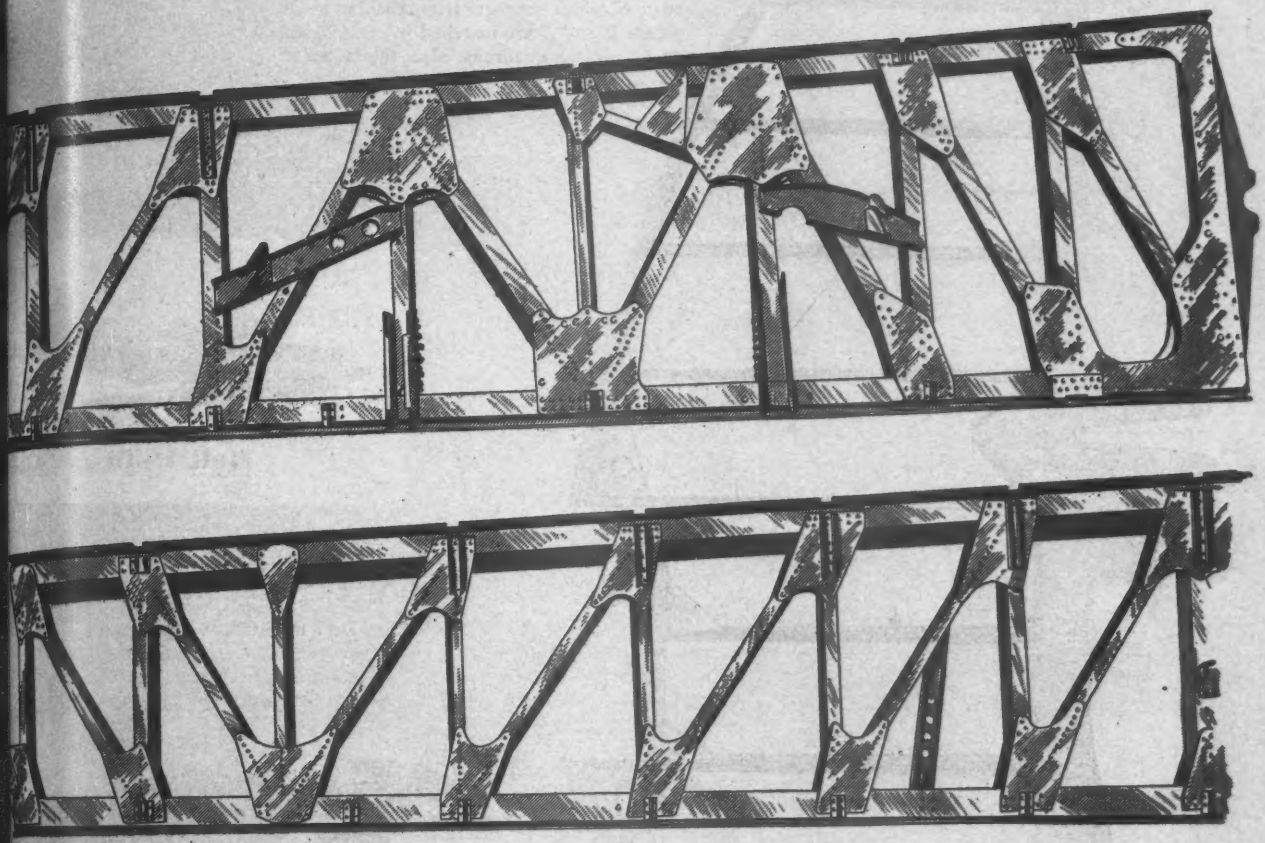
Boeing B-17



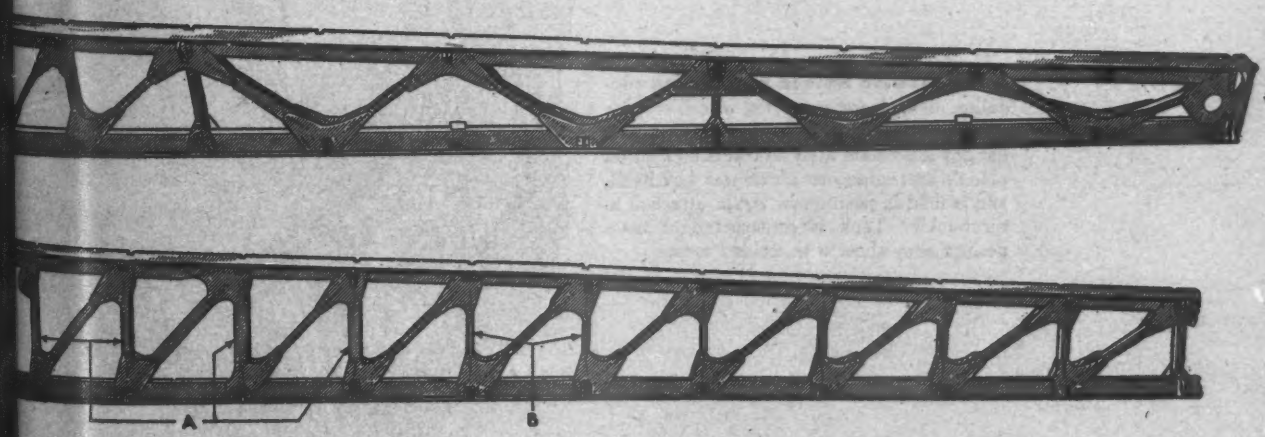
Detail of Fortress rudder mechanism shows rudder *A*, supported on shaft *B*, with pivot point at *C*. Control cable *D* is matched by counterpart on opposite side of shaft. Arms *E* connected to control cables and bracket *F* serve as adjustable brace to align rudder. Whole unit is attached to fuselage by truss support *G*. Rudder is locked by pin extended from fuselage into quadrant at *H*.

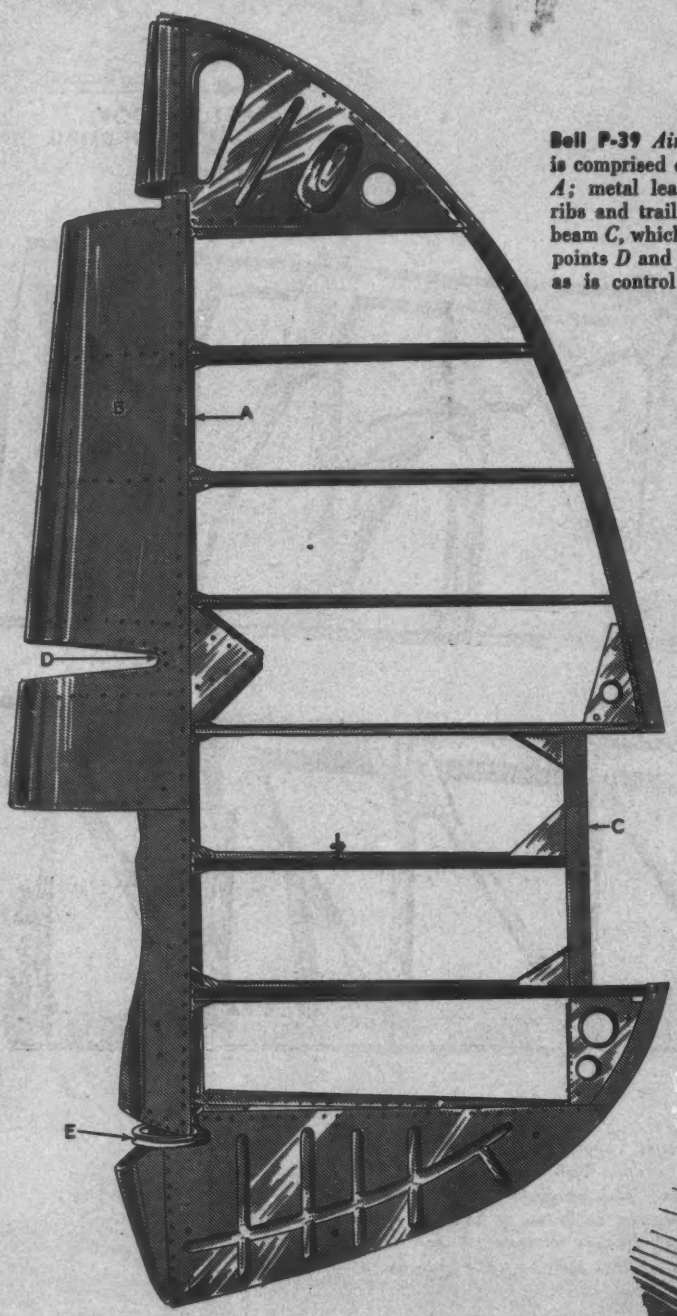


Inboard wing fuel tank of B-17 suspended on padded metal banks s pended from carrier-ribs hinged points *A*, *B*, *C*, *D* and *E*, with openi in top skin to filler ports at *F* and



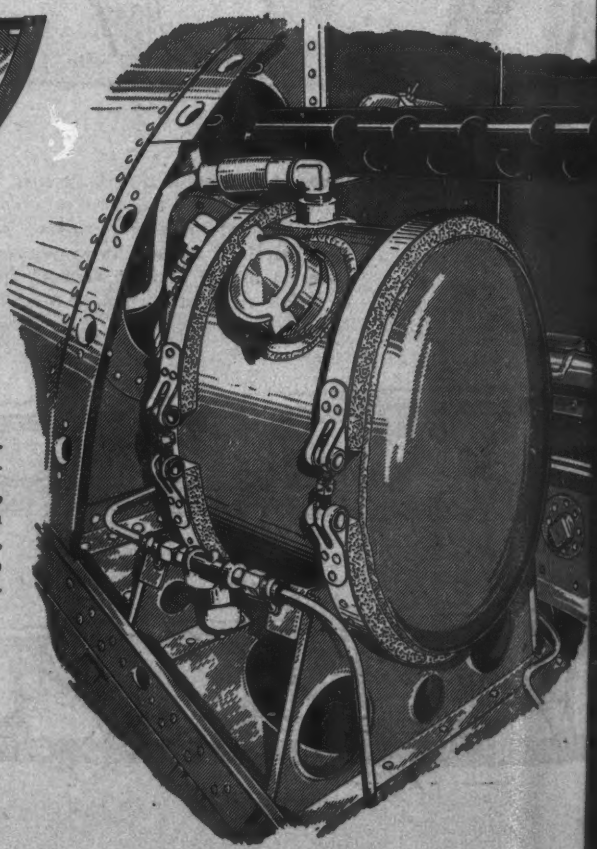
Inboard section of B-17 front spar (above) utilizes two versions of modified Howe truss construction. This view is of rear of spar. Outboard rear spar (below) also employs two versions of modified Howe trusses. Inner portion is shown at bottom. Note variation in size between vertical channel members *A* and those at *B* and, in outer portion, that vertical members are eliminated.



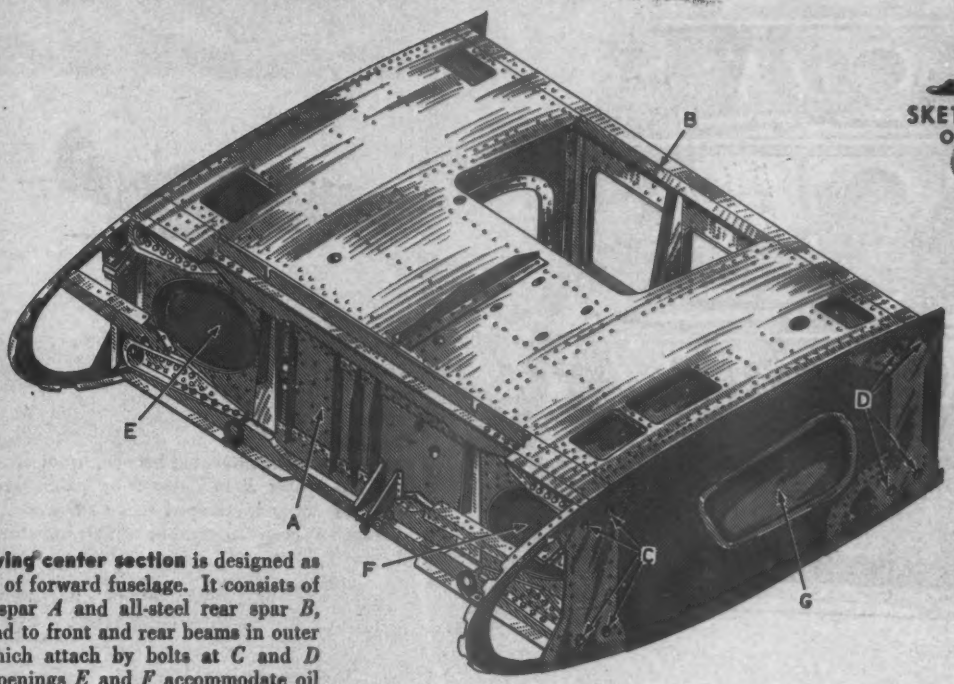


Bell P-39 *Airacobra* fabric-covered rudder is comprised of channel shaped main beam *A;* metal leading edge formers *B;* metal ribs and trailing edge and metal auxiliary beam *C,* which supports trim tab. Two hinge points *D* and *E* are installed in main beam, as is control quadrant, also shown at *E.*

Bell P-39

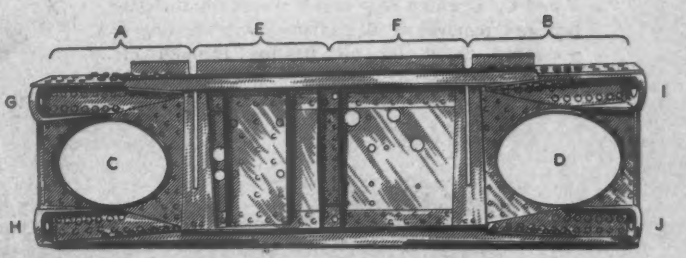


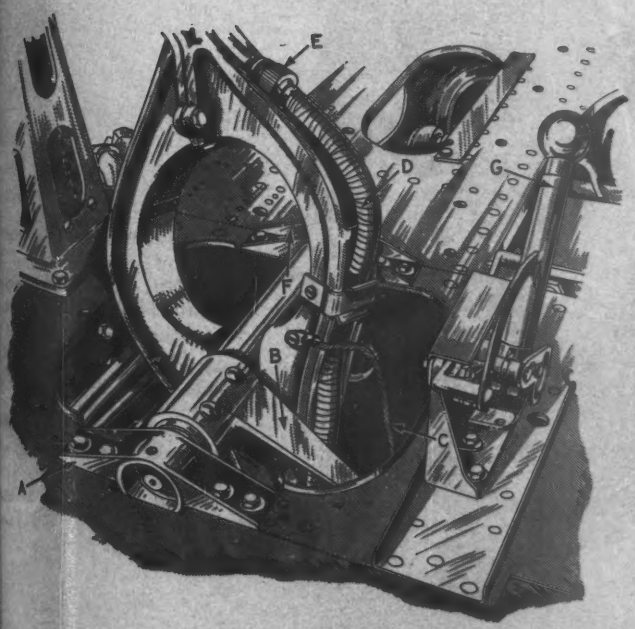
Detail showing method of mounting two-gallon oil tank for supplying propeller gear reduction box. Tank is mounted on stamped, flanged aluminum alloy brackets located on plane's centerline just aft of gear box itself, and is held in position by straps attached to turnbuckle. Tank is constructed of magnesium alloy sheet with welded seams.



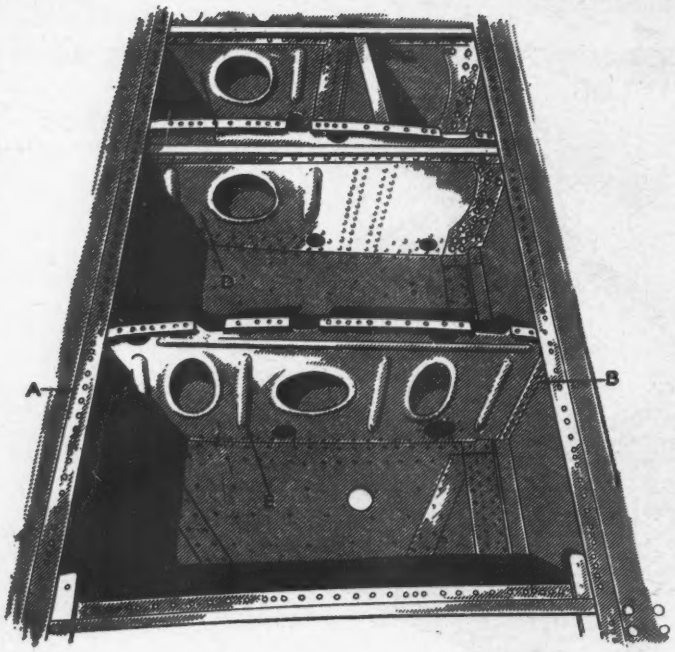
AIRACOBRA wing center section is designed as an integral part of forward fuselage. It consists of built up front spar *A* and all-steel rear spar *B*, which correspond to front and rear beams in outer wing panels which attach by bolts at *C* and *D* respectively. Openings *E* and *F* accommodate oil radiator ducts.

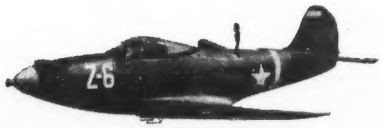
Forward center section beam, also shown in sketch above, is built up of four major sections. Outside panels *A* and *B* consist of three layers of heavy gage aluminum, with outer layers having formed, 90 deg. flanges top and bottom and with access holes *C* and *D* to accommodate oil cooler ducts. Inside panels *E* and *F* are solid single layers. Four wing bolt fittings *G*, *H*, *I*, and *J* are attached by bolts.





P-39 control column employs yoke construction to afford opening through which drive shaft from aft-mounted engine passes to propeller reduction gear box in nose. This detail, looking aft, shows fore mounting bracket *A*, aileron control link *B*, bonding wire *C*, electric firing cable *D* with disconnecting plug *E* and aft mounting bracket *F*. Bomb arming lever is at *G*.

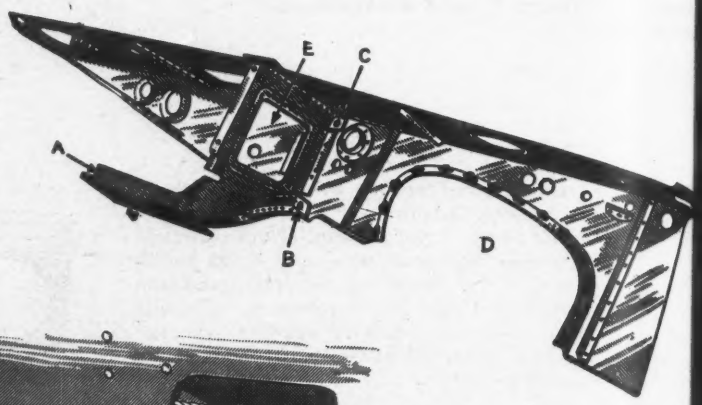


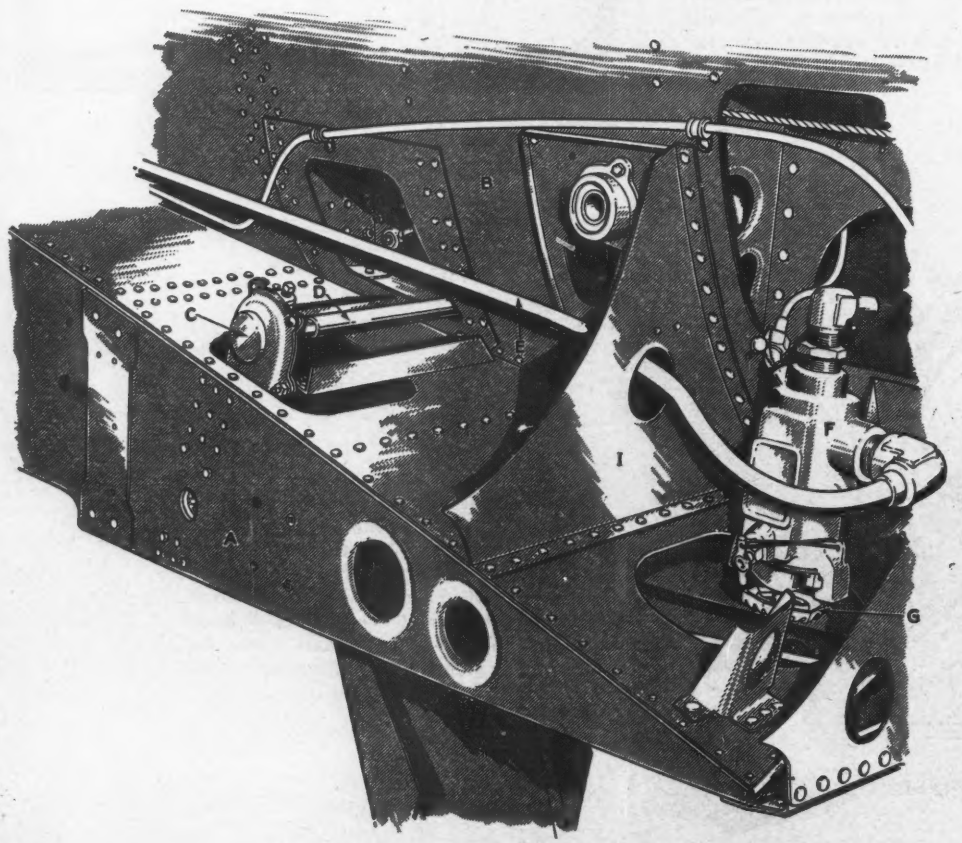


Bell P-39

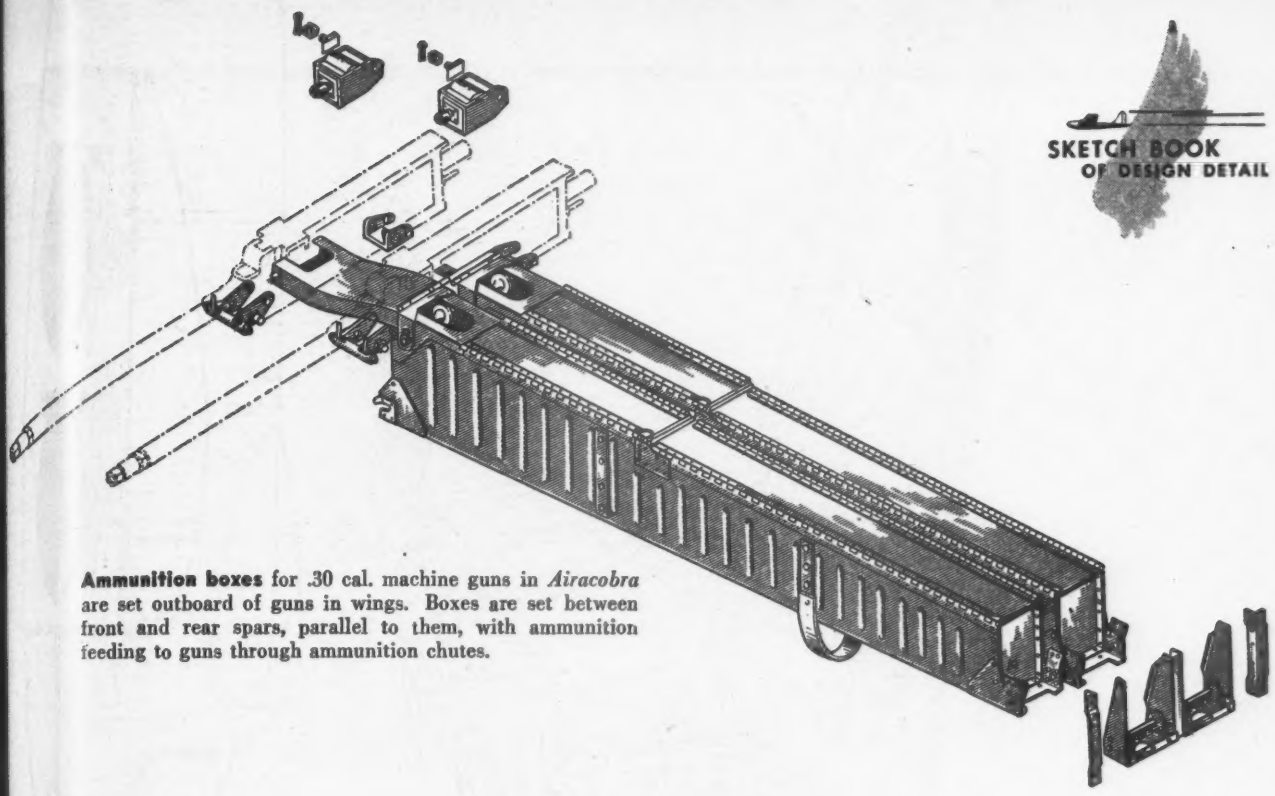
Typical fuel tanks, located between front spar *A* and rear spar *B* in outer wing panel, are formed by flanged, stamped ribs *C, D* and *E,* to create structure to contain self-sealing fuel cells

Structural detail of part of left side of wing center section fairing just aft of all-steel rear beam. Tie-through to similar unit on opposite side is through built-up T-section attaching at *A*. Outer panel auxiliary beam attaches on opposite side at *B* and *C*. Opening *D* provides access for installation and removal of oil radiator, with opening *E* providing outlet for air passing through oil radiator.





Detail showing installations junction of trailing edge of l side of *Airacobra* center sectio *A*, and fuselage *B*. Flap actuati sprocket housing is shown at power being delivered throu drive shaft *D*, which is attache to motor located on opposite si of fuselage. *E* is fuel line leadi to Lunkenheimer strainer *F*, wi drain cock which may be ha operated at *G*. Fairing betwe fuselage and wing will follo contour outlined by plate *I*.

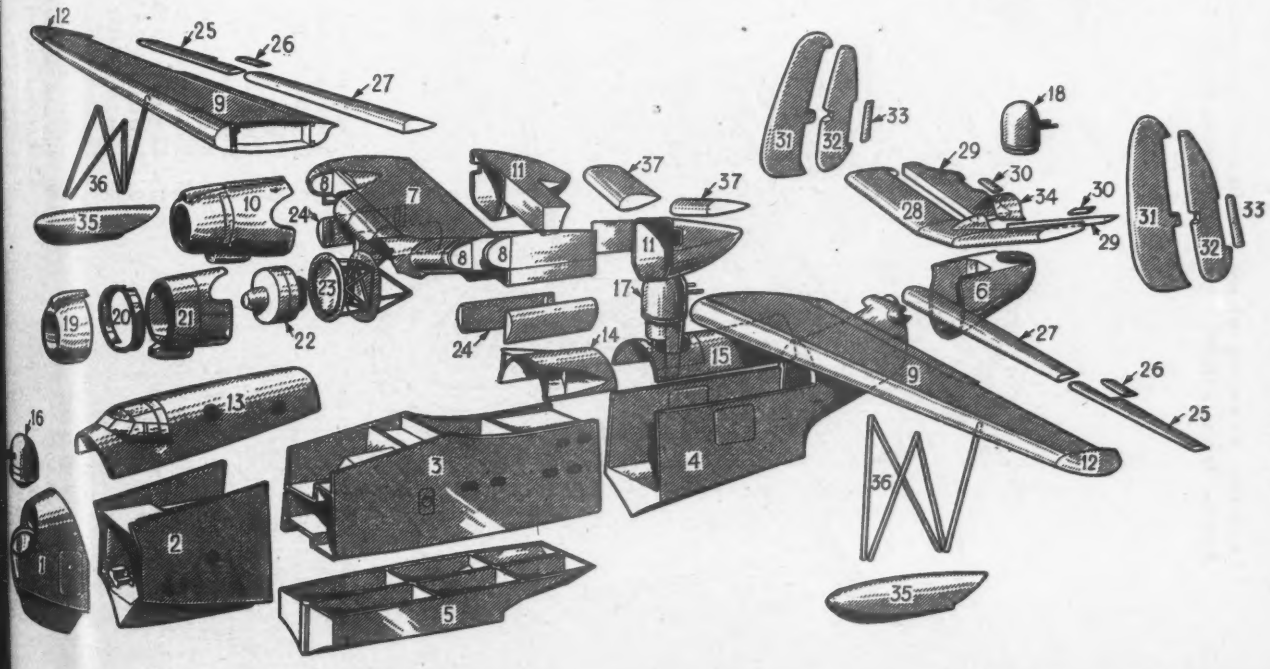


Ammunition boxes for .30 cal. machine guns in *Airacobra* are set outboard of guns in wings. Boxes are set between front and rear spars, parallel to them, with ammunition feeding to guns through ammunition chutes.

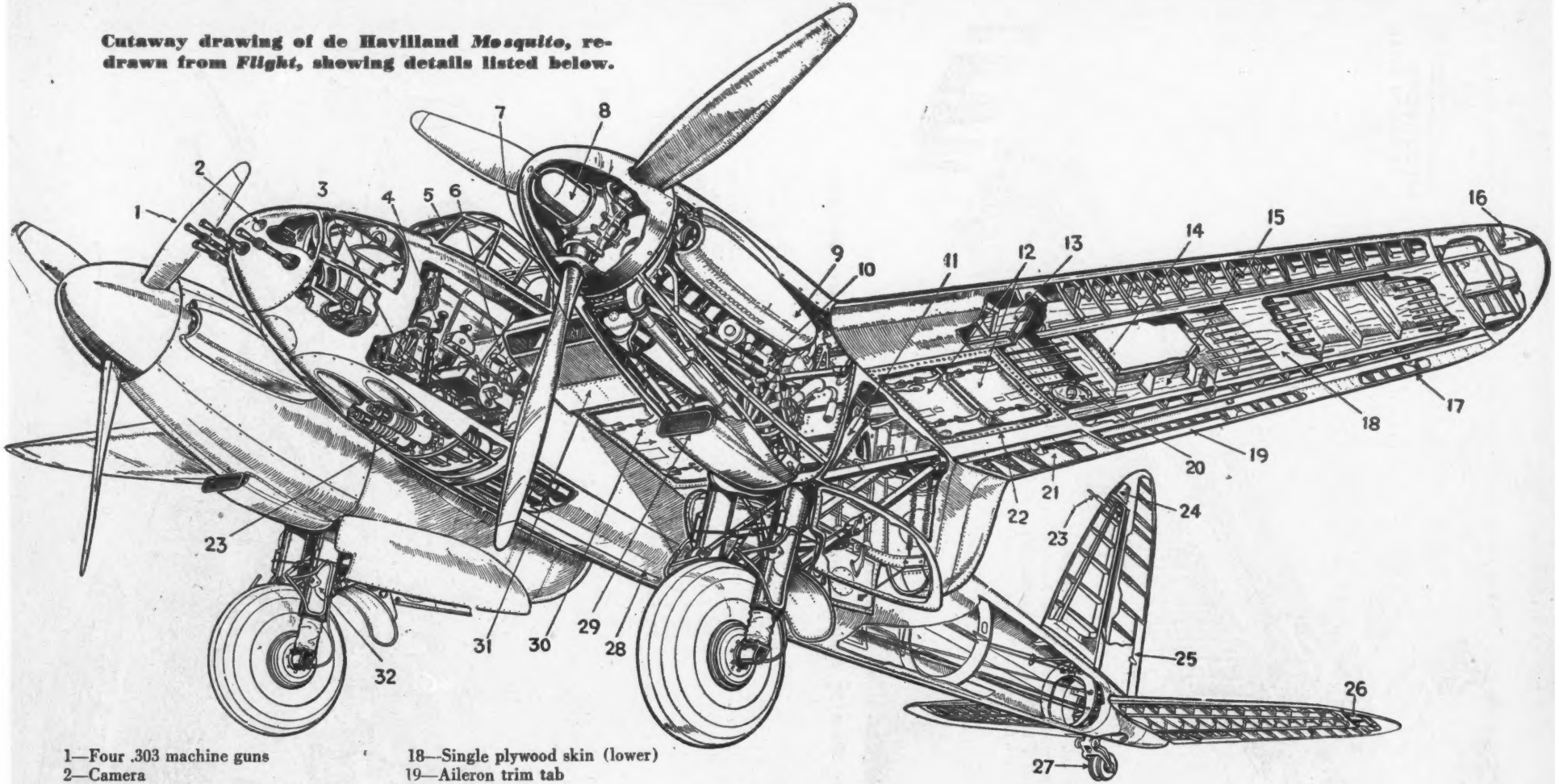
Martin PBM-3

Exploded view showing major components of "Mariner" patrol bomber

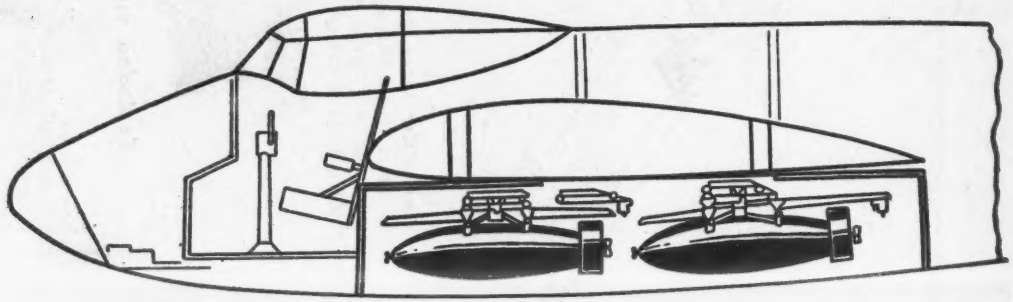
1. Nose section
2. Forward hull section
3. Center hull section
4. After hull section
5. Tank hull section
6. Tail hull section
7. Center wing
8. Motor rib
9. Outer wing
10. Nacelle, forward section
11. Nacelle, beavertail
12. Wing tip
13. Pilot's enclosure
14. Auxiliary power plant cowling
15. Turtleback
16. Nose gun turret
17. Turtleback gun turret
18. Tail gun turret
19. Engine cowling
20. Engine cowl flaps
21. Engine mount housing
22. Engine
23. Engine mount
24. Nacelle bomb bay doors
25. Aileron
26. Aileron trim tab.
27. Wing flap
28. Stabilizer
29. Elevator
30. Elevator trim tab
31. Fin
32. Rudder
33. Rudder trim tab
34. Tail gun turret fairing
35. Float
36. Float struts
37. Inboard wing flap

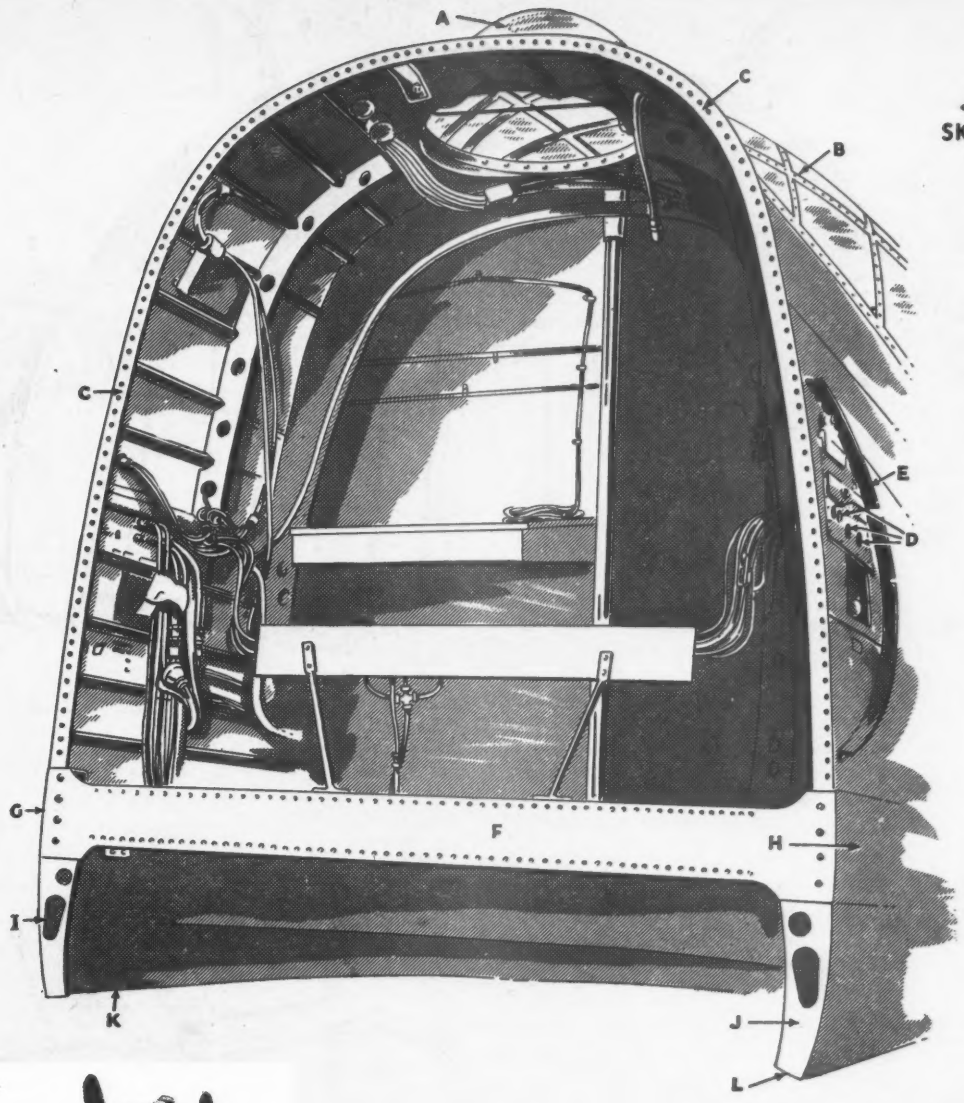


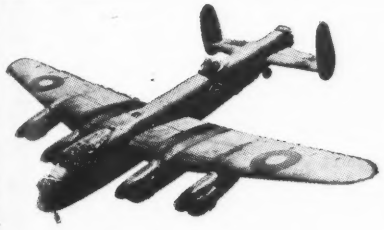
Cutaway drawing of de Havilland *Mosquito*, redrawn from *Flight*, showing details listed below.



1—Four .303 machine guns
2—Camera
3—Rudder pedals
4—Control column
5—Bullet proof screen
6—Pilot's seat
7—Oil and glycol radiators
8—De Havilland hydromatic airscrews
9—Exhaust flame damper
10—Rolls-Royce *Merlin XXI* 12 cyl. engines
11—Landing gear hydraulic jack
12—Outboard fuel tanks
13—Front main spar
14—Spaced double skin (upper)
15—Rear main spar
16—Navigation light
18—Single plywood skin (lower)
19—Aileron trim tab
20—Landing light
21—Flap
2—Fuel tank cover
23—Pilot head
24—Rudder mass balance
25—Rudder trim tab
26—Elevator mass balance
27—Retractable tail wheel
28—Gun bay folding doors
29—Carburetor air intake with anti-ice guards
30—Inboard fuel tanks
31—Radiator shutter
32—Compression rubber landing gear leg

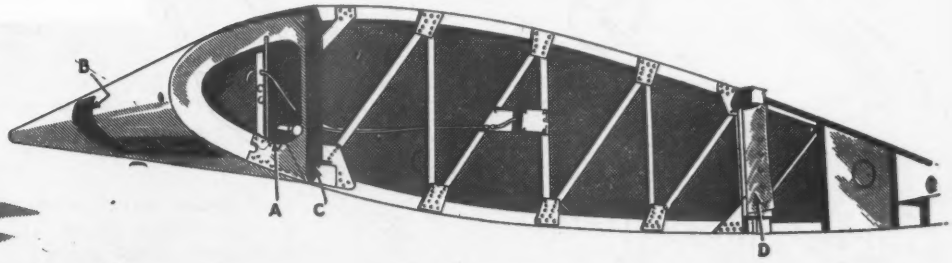


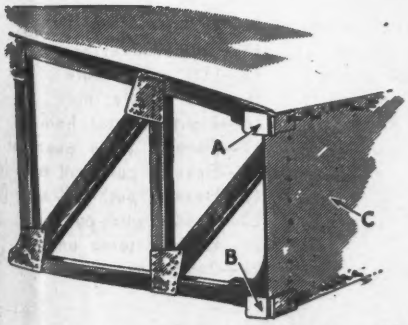




Avro Lancaster

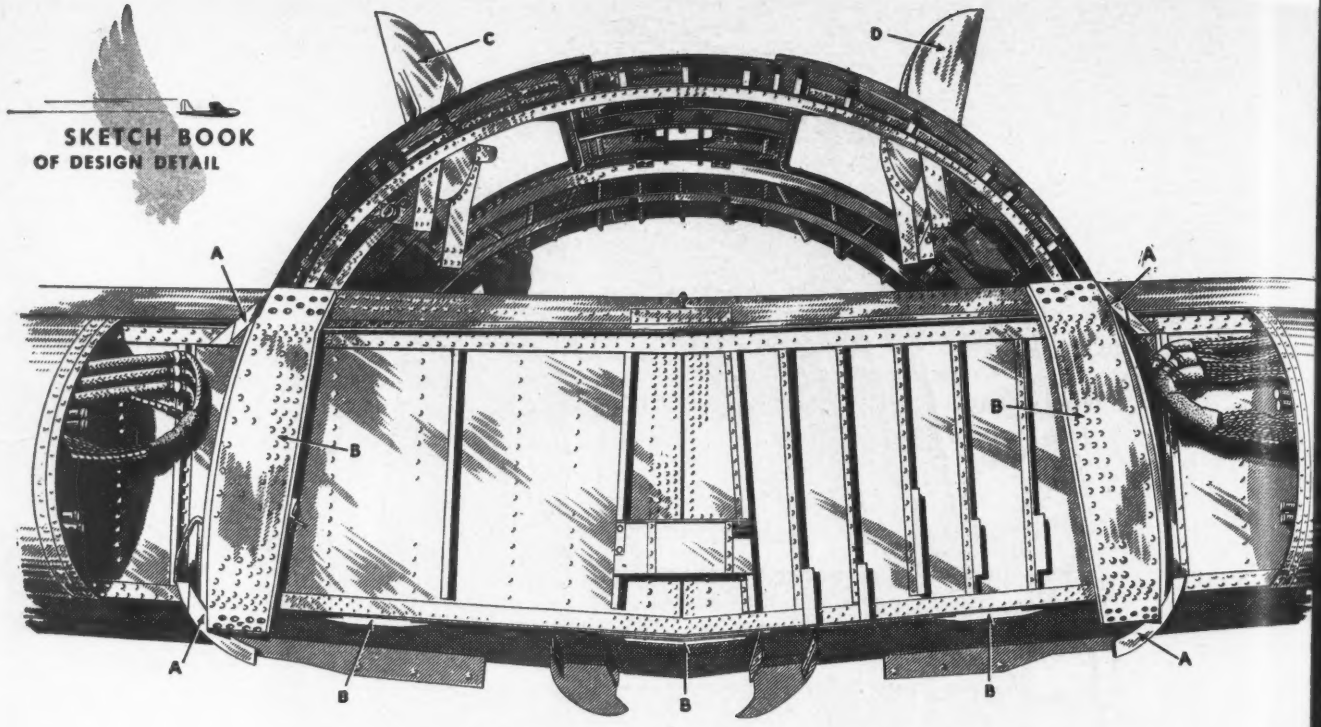
Cross section of Avro *Lancaster* fuselage at aft end of front center portion, showing navigator's astradome *A*, which is located at rear end of pilot's cabin *B*. This section of fuselage attaches to center or intermediate fuselage section by bolts through angle frame *C*. Controls go out to wing through openings *D* into leading edge of wing, fairing for which is shown on fuselage at *E*. Fuselage floor consists of transverse members, such as *F*, intercostals and extruded side members *G* and *H*. Fuselage floor also forms bombbay top, with fuselage sides *I* and *J* extending down as supports for bombbay doors at hinge line *K* and *L*.



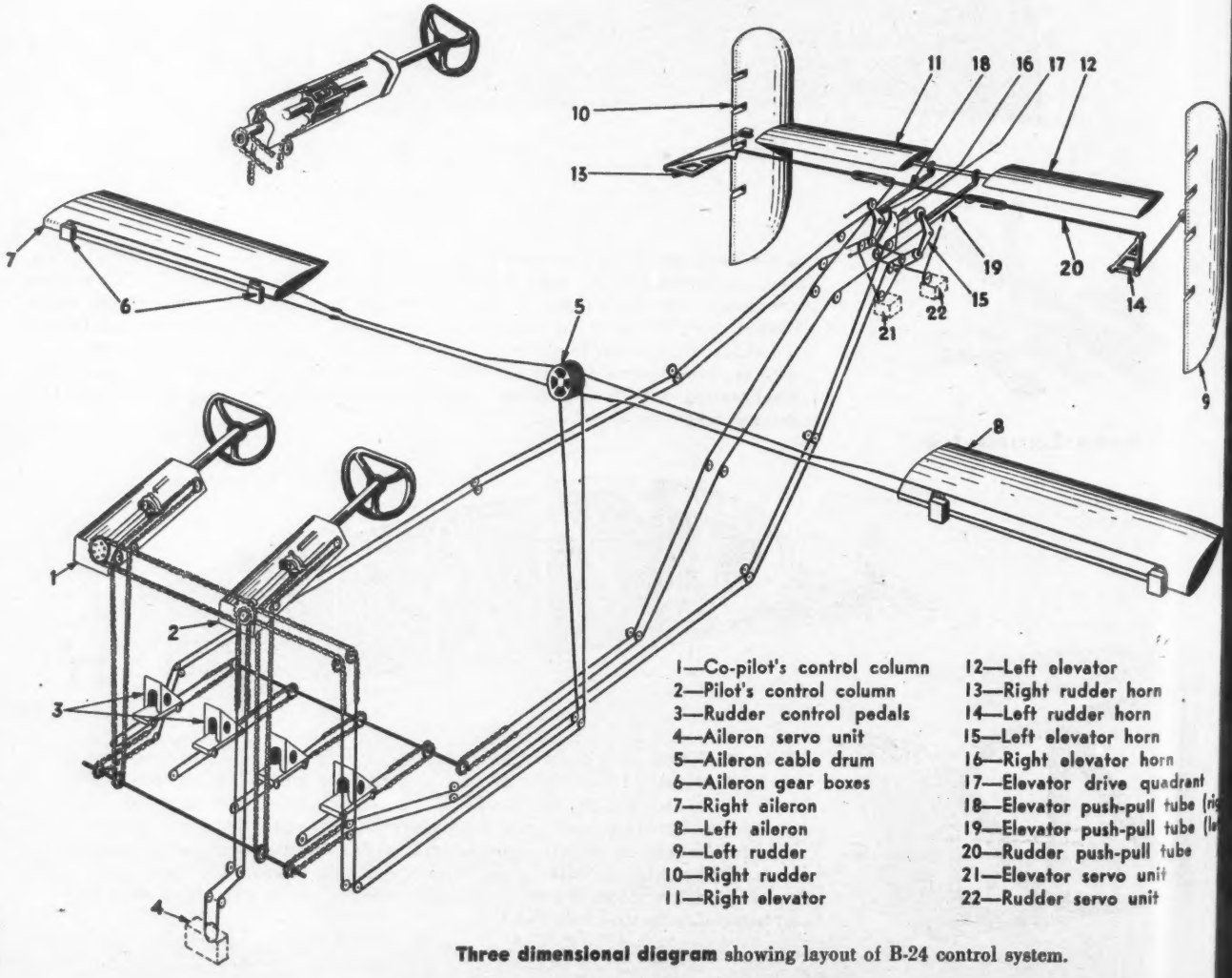


Cross sectional view of *Lancaster* outer wing panel showing built-up truss type rib used on both sides of engine mounts. Control lines seen in leading edge at *A* lead to outboard engine, which will be mounted at *B*. A fuel tank will be mounted within wing in area next to rib between front spar *C* and rear spar *D*. Rib on other side of fuel cell space is conventional built-up flanged alclad sheet with lightening holes. Detail at left shows rib at rear spar which is built up of extruded milled booms *A* and *B*, which are attached to flat web alclad sheet *C* by nickel chrome steel nuts and bolts.

SKETCH BOOK OF DESIGN DETAIL



Front view of detail of Consolidated Vultee B-24 *Liberator* center section, showing fuselage-to-wing attachment angles at four points *A*, and wing-to-fuselage attachment fittings at five points *B*. *C* and *D* are emergency escape hatches in top of fuselage.

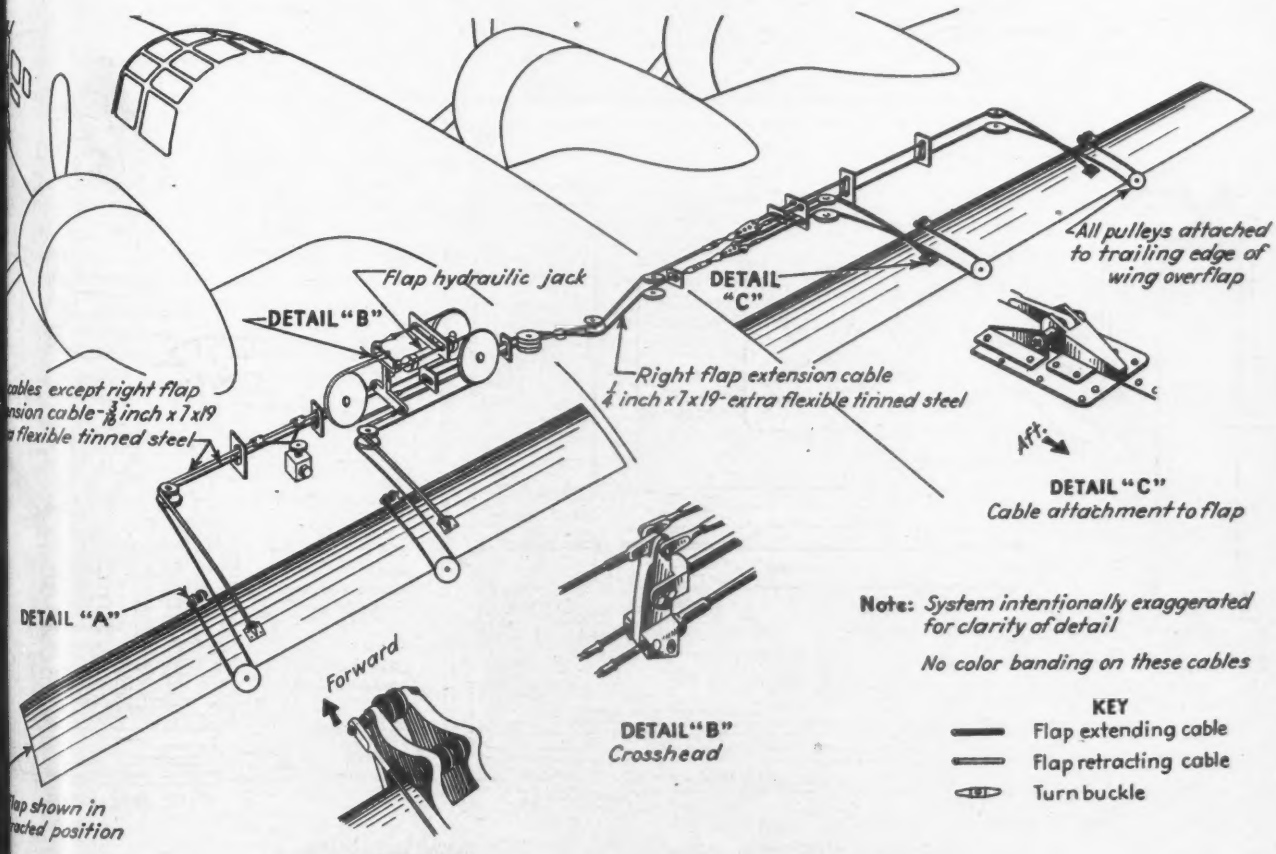


1—Co-pilot's control column
2—Pilot's control column
3—Rudder control pedals
4—Aileron servo unit
5—Aileron cable drum
6—Aileron gear boxes
7—Right aileron
8—Left aileron
9—Left rudder
10—Right rudder
11—Right elevator
12—Left elevator
13—Right rudder horn
14—Left rudder horn
15—Left elevator horn
16—Right elevator horn
17—Elevator drive quadrant
18—Elevator push-pull tube (ri
19—Elevator push-pull tube (l
20—Rudder push-pull tube
21—Elevator servo unit
22—Rudder servo unit

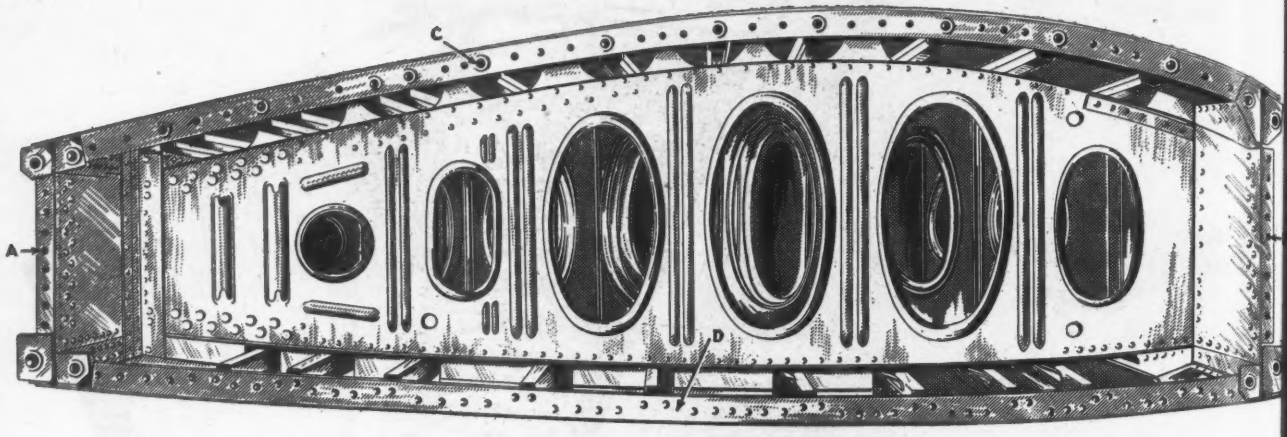
Three dimensional diagram showing layout of B-24 control system.

B-24 Liberator

Liberator flap in extended position, looking inboard toward fuselage with aileron at *A*. Flap track support and flap track itself are shown at *B* and *C*, respectively, and flap carriage at *D*. Flap extending cable attachments are located at *E*. Landing wheel fairing is at *F* and engine nacelle fairing at *G*.



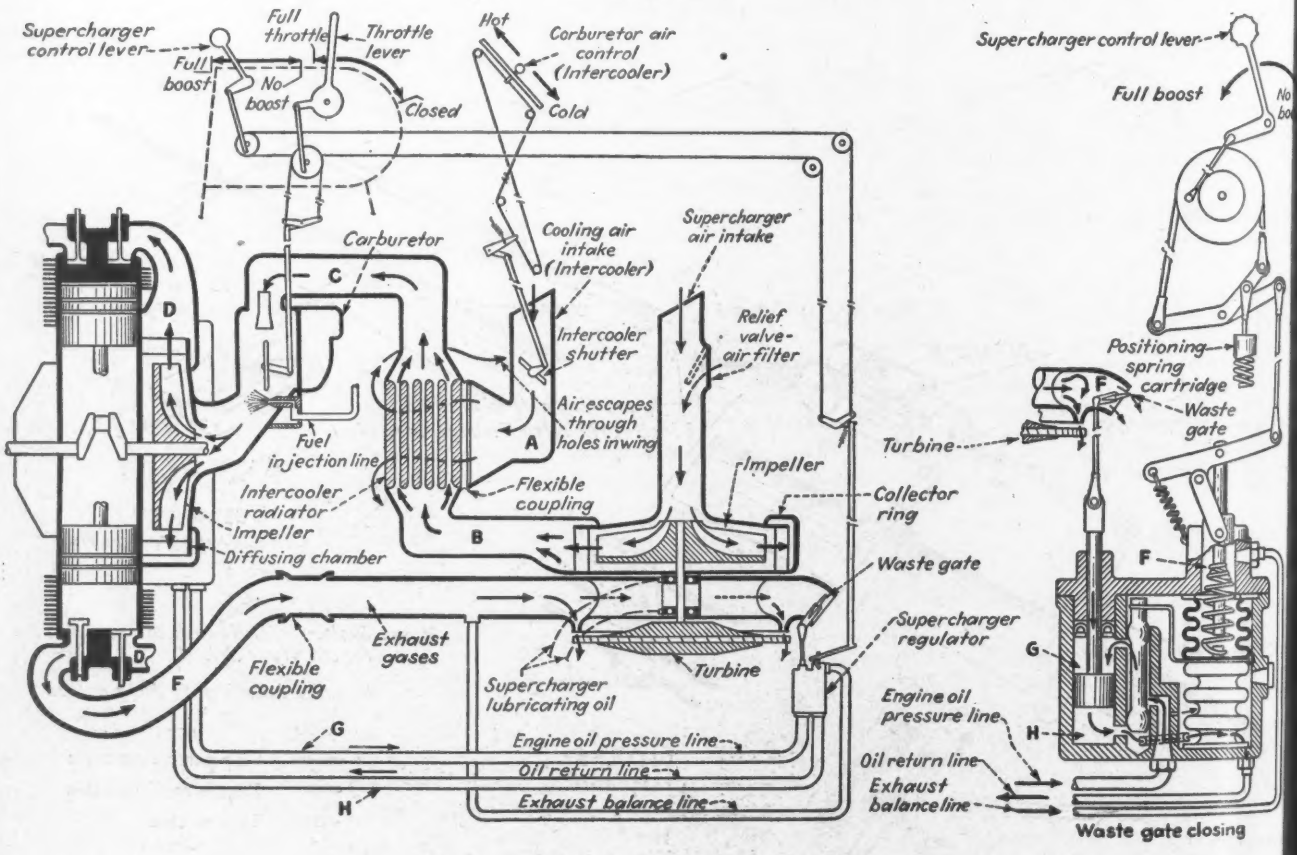
Three dimension diagram of flap cable system employed on B-24.



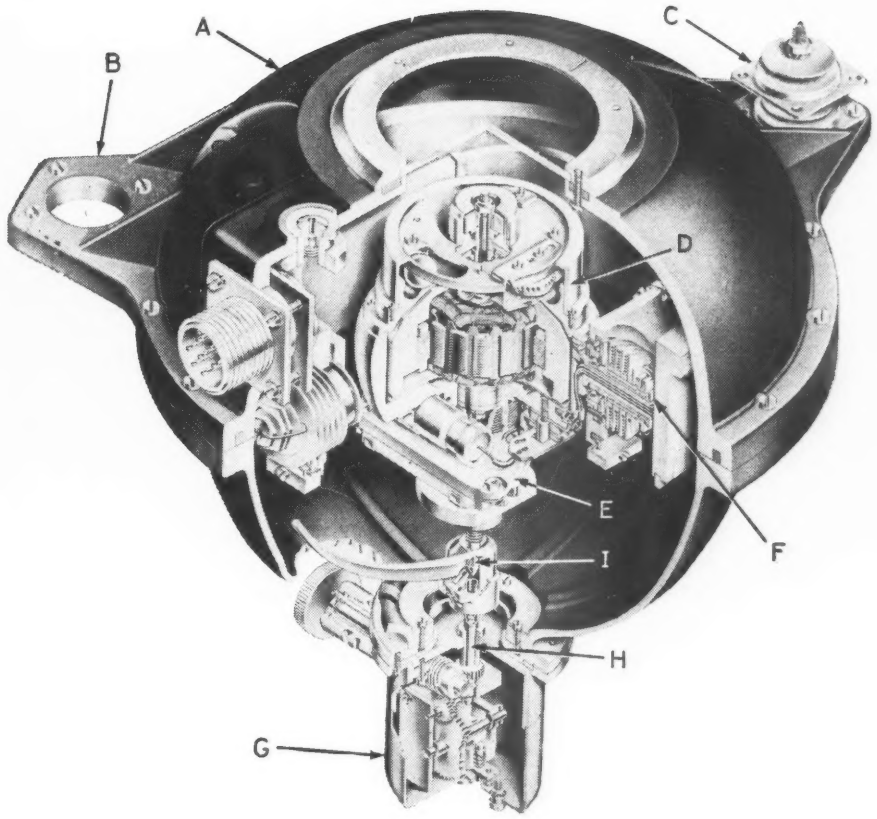
Cross section of Liberator outer wing panel, looking outboard at splice. Attaching bolts for rear spar *A* are accessible from outside wing, while those at front spar *B*, are accessible through removable firewall which is attached to spar. Attaching bolts for top surface, *C* and bottom surface *D* are accessible only from inside wing.

H	G	F	E	D	C	B	A
Oil return	Engine oil pressure	Exhaust	Compression	"C" Plus impeller pressure	"A" Plus "B" Minus pressure drop through cooler	"A" Plus turbo pressure	Atmospheric and ram pressure

LEGEND

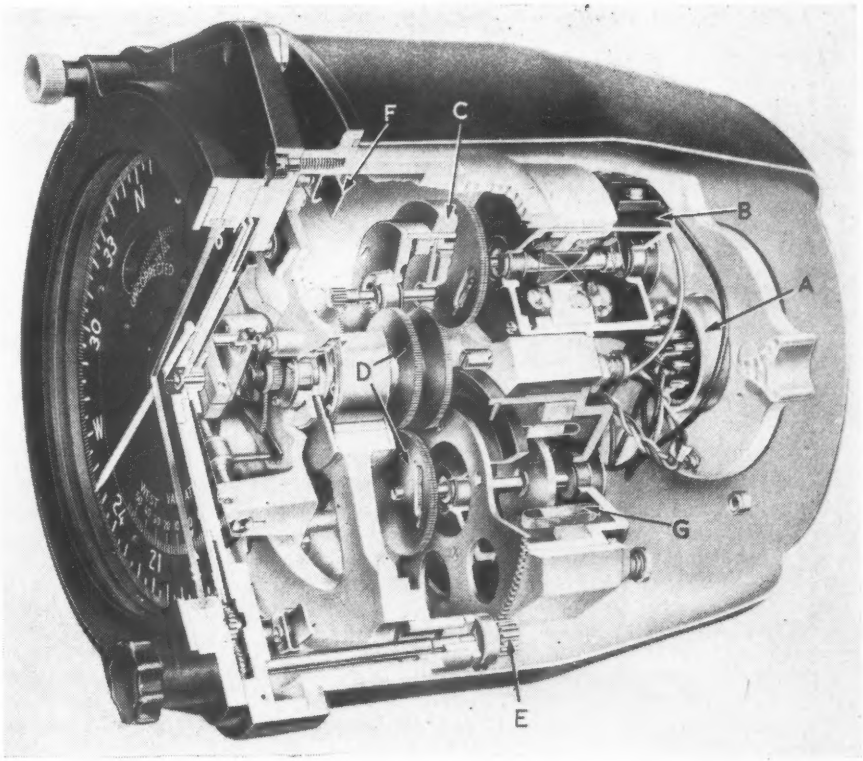


Schematic diagram of supercharger flow in B-24 engine installation.

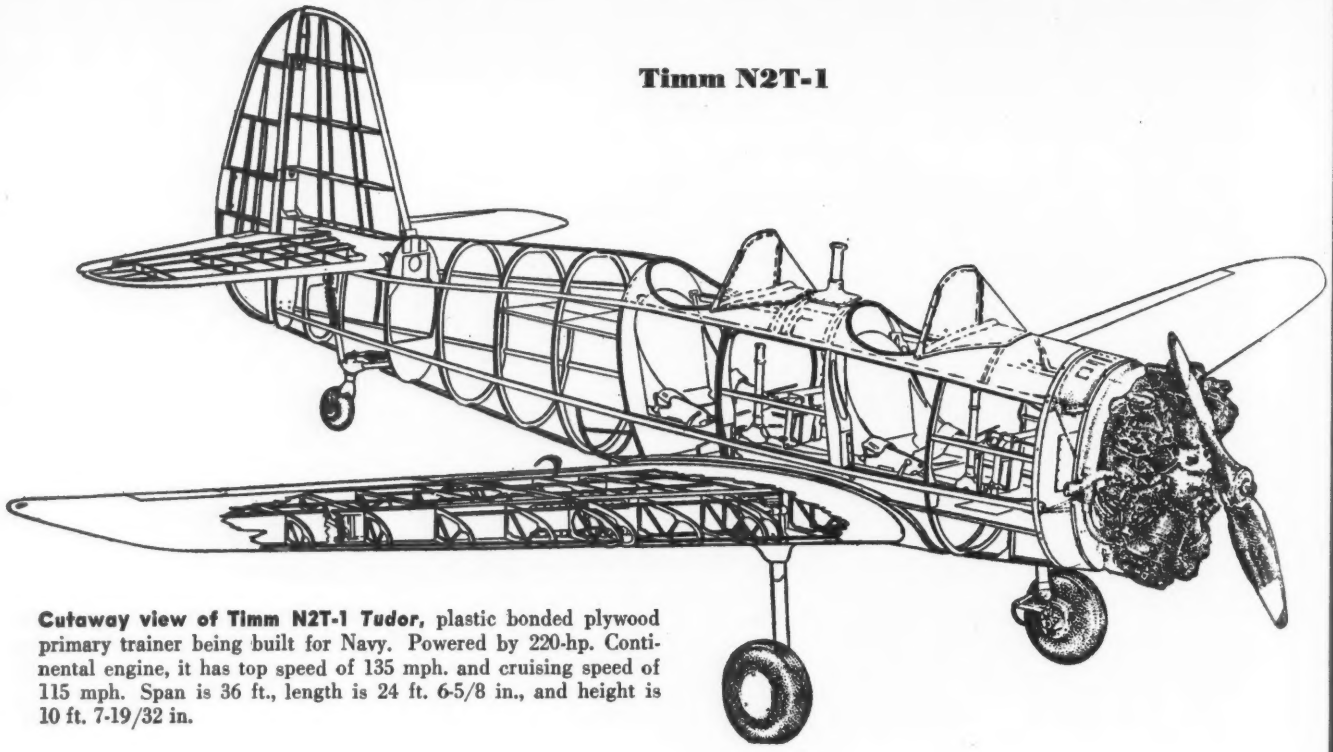


Pioneer Gyro Flux Gate Compass

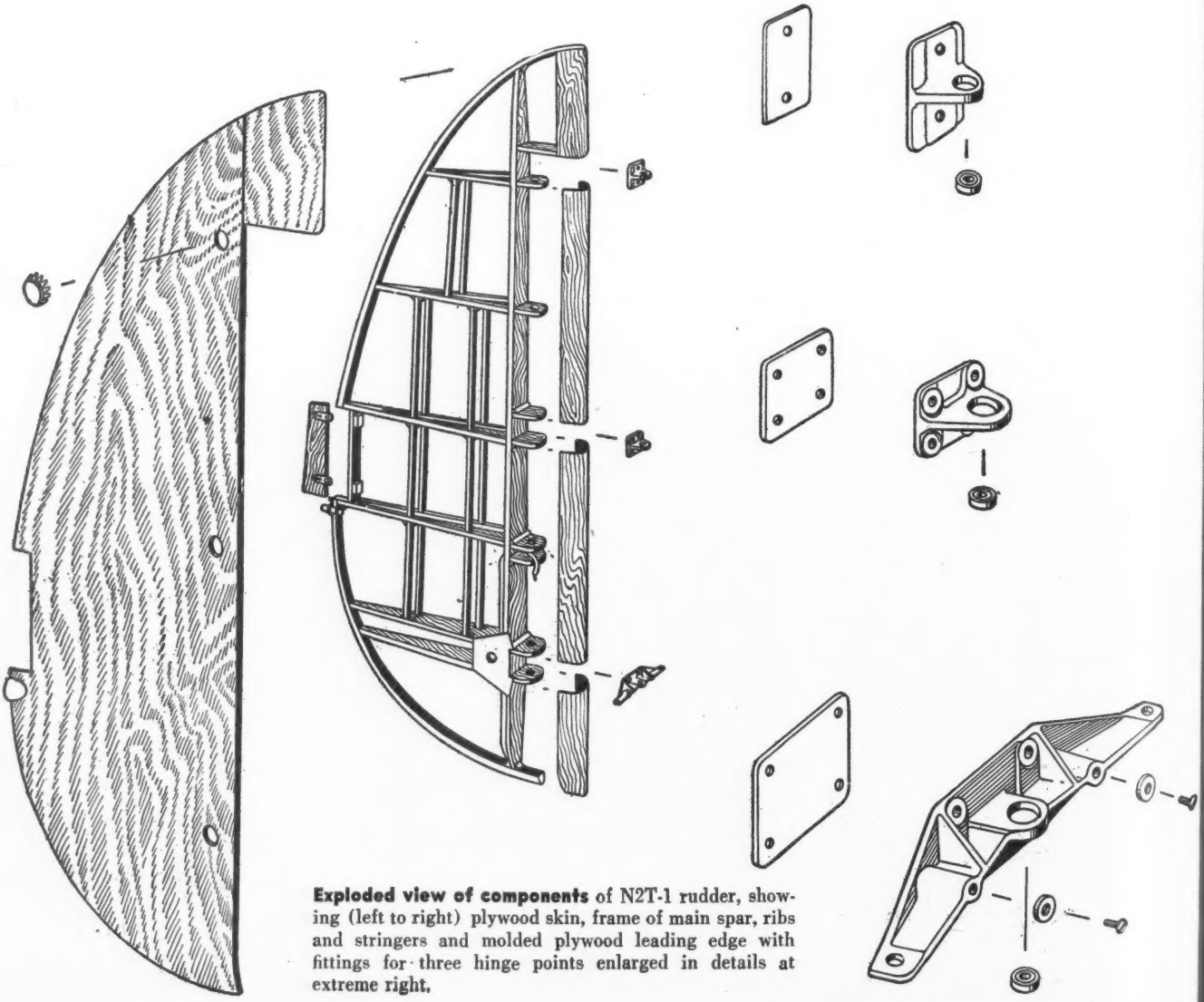
Cutaway views showing details of Pioneer Gyro Flux Gate Compass transmitter *A*, and master indicator. Set in plastic housing, transmitter unit may be located through three attaching points—two of which are shown at *B* and *C*—at most suitable place in aircraft to remove it from disturbances set up by armor or other ferrous masses. Gyroscopic unit *D*, suspended in gimbal ring *F* is used as stable platform for flux gate element, the triangular unit at *E*. Remote caging unit connected at *G* is used solely to erect gyro from positions greatly off vertical. This is done through an electrically actuated flexible cable which raises and rotates shaft *H* into contact with caging arm *I*. Master indicator, right, receives impulses from transmitter through connections at *A* and consists of autosyn *B*; two-phase induction motor *C*; gear train *D* and manually operated adjusting mechanism *E* by means of which correction for variation can be introduced. Contour of cam *F* is adjusted to compensate for deviation. Up to six repeater indicators may be electrically connected to transmitter magnesyn *G* and located in different parts of aircraft to operate synchronously with master indicator.



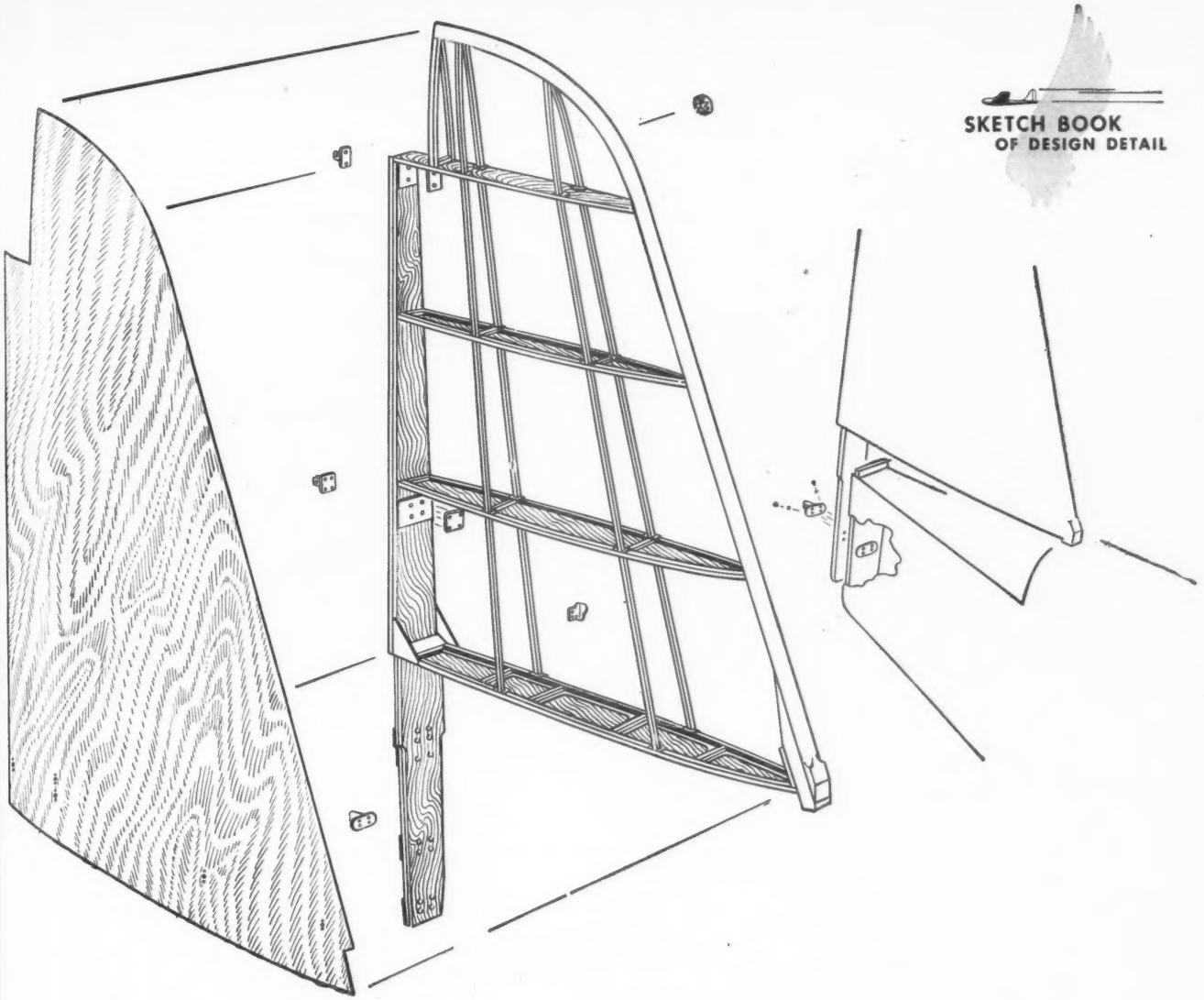
Timm N2T-1



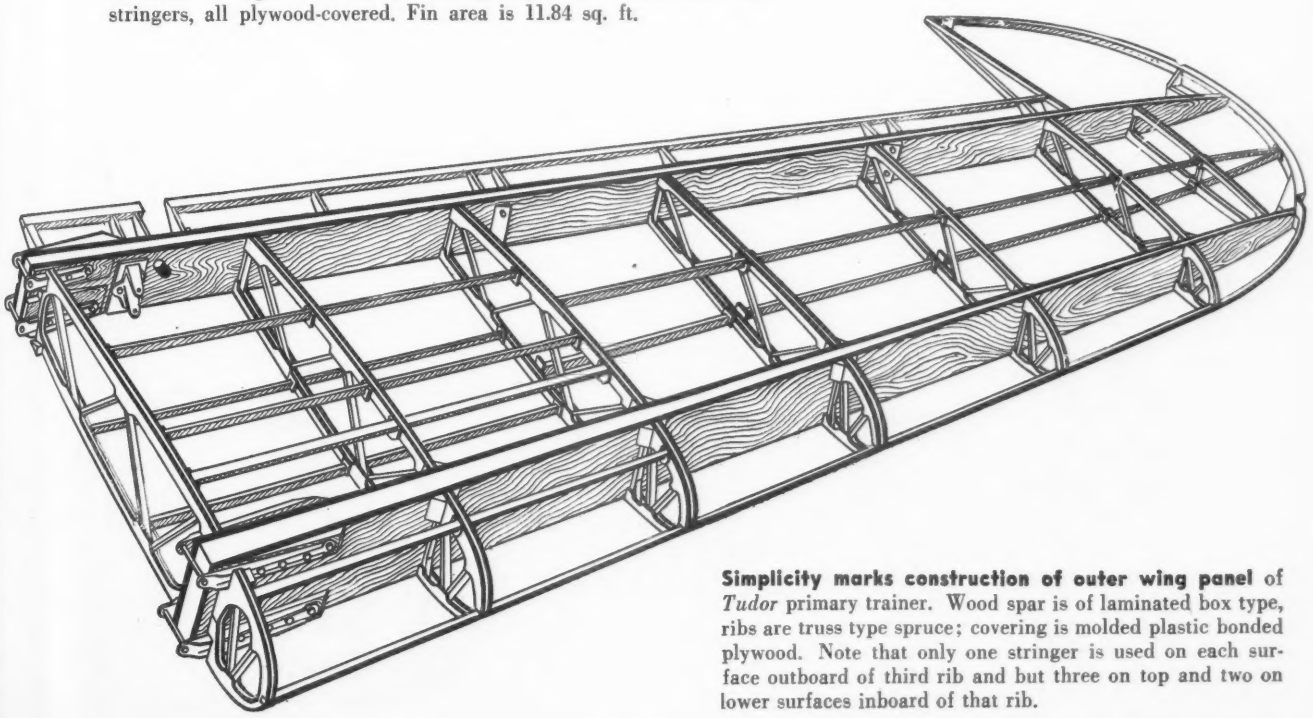
Cutaway view of Timm N2T-1 *Tudor*, plastic bonded plywood primary trainer being built for Navy. Powered by 220-hp. Continental engine, it has top speed of 135 mph. and cruising speed of 115 mph. Span is 36 ft., length is 24 ft. 6-5/8 in., and height is 10 ft. 7-19/32 in.



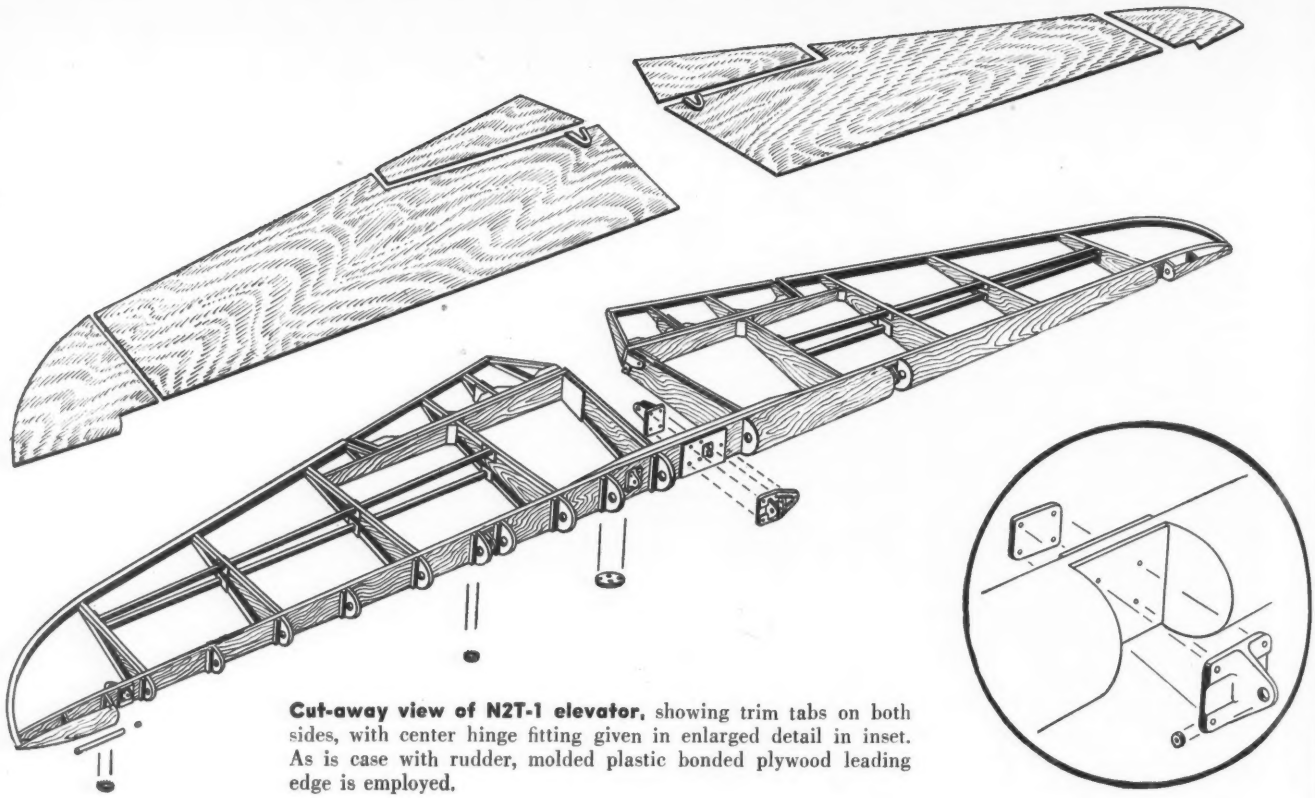
Exploded view of components of N2T-1 rudder, showing (left to right) plywood skin, frame of main spar, ribs and stringers and molded plywood leading edge with fittings for three hinge points enlarged in details at extreme right.



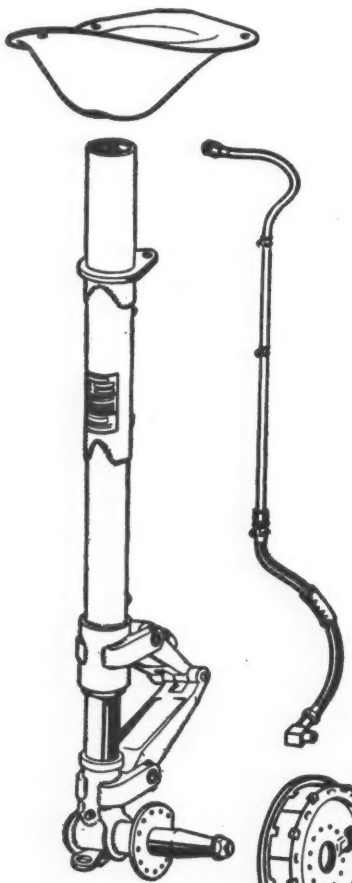
With exception of fittings, vertical fin is all-wood construction, consisting of main spar, which extends down into fuselage—as shown in detail at right—with wood leading edge, four wood ribs and stringers, all plywood-covered. Fin area is 11.84 sq. ft.

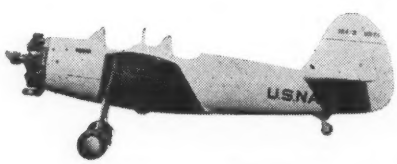


Simplicity marks construction of outer wing panel of *Tudor* primary trainer. Wood spar is of laminated box type, ribs are truss type spruce; covering is molded plastic bonded plywood. Note that only one stringer is used on each surface outboard of third rib and but three on top and two on lower surfaces inboard of that rib.



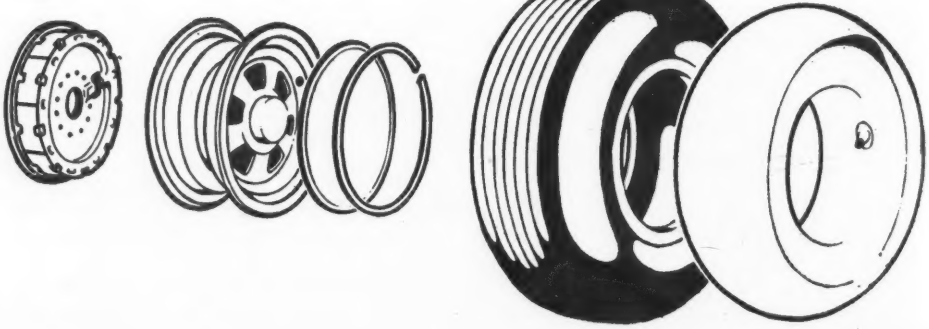
Cut-away view of N2T-1 elevator, showing trim tabs on both sides, with center hinge fitting given in enlarged detail in inset. As is case with rudder, molded plastic bonded plywood leading edge is employed.



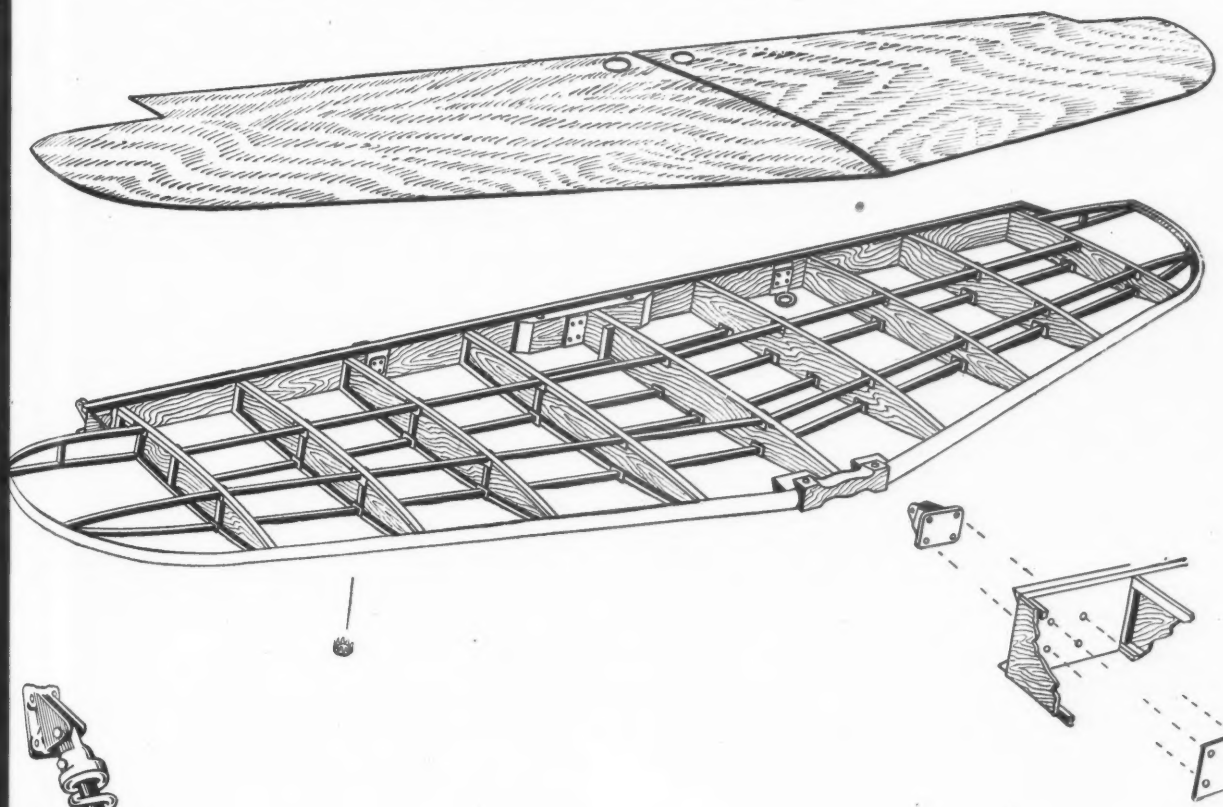


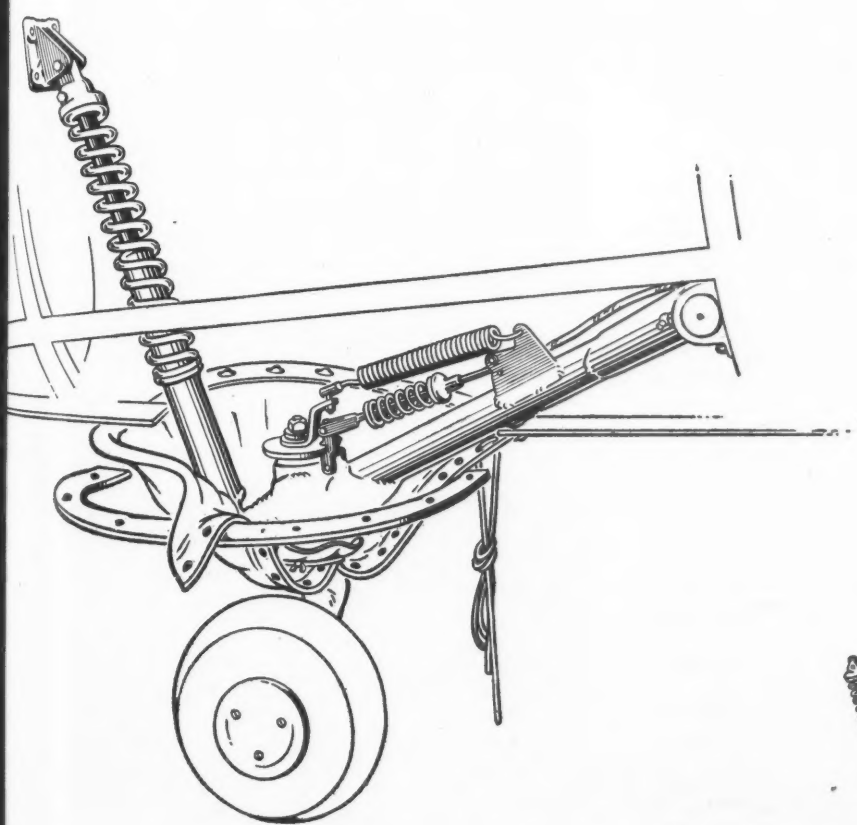
Timm N2T-1

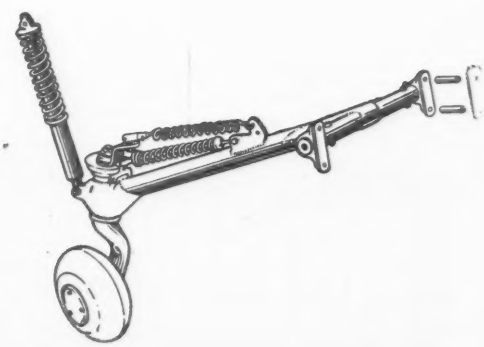
Exploded view showing components of main landing gear, which is fixed type. Shock unit is air oil type, wheel is 22-in. diam. Hayes G-3-73 and brake is Hayes G-2-122 type.



As is case with other units on *Tudor*, full cantilever stabilizer is of simple wood construction with metal fittings. Three stringers are used on lower surface between center and first ribs on each side; from there to tips two for each surface are used. Covering is molded plastic bonded plywood.







Tail wheel installation of N2T-1 is shown above, with components of unit itself shown in detail at right. Tire is 10 in. smooth contour. Unit is free swiveling and lockable, lock unit being shown just above pivot point between thrust strut and shimmy damping spring unit.

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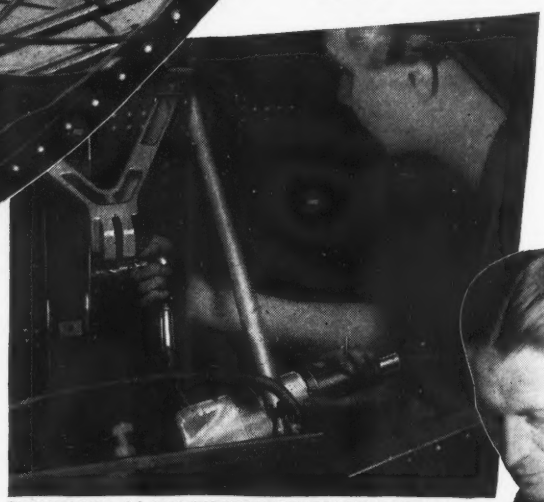

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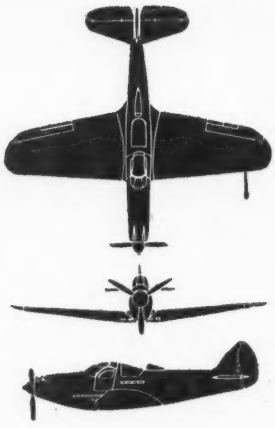
American

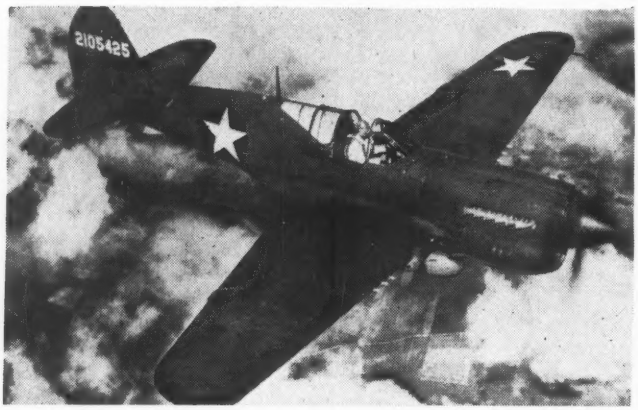
Fighters

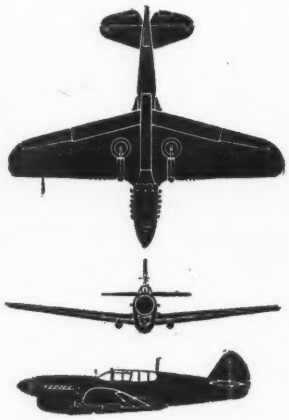


Bell P-39 *Airacobra*

America's first cannon-mounting single-place fighter and only operational pursuit with engine mounted behind the pilot. In addition to 37-mm. cannon firing through propeller hub, six .50-cal. machine guns are mounted in wings. Serving in every war theater, the P-39 is a great favorite of the Russians, who call it *Little Shaver*, since they term low-level attack work "shaving." Also see AVIATION for May, 1943, page 126.

Span.....34 ft.
Length.....30 ft. 2 in.
Height.....9 ft. 3¼ in.
High speed.....over 380 mph.
Gross wt.....7,496 lb.
Power.....one 1,150-hp. Allison

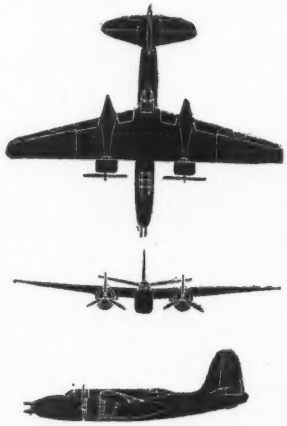




Curtiss P-40N *Warhawk*

Latest of the famed "Hawk" series on which information has been released, representing continuous refinements which have constantly added to performance. Its predecessors were the planes used by Gen. Chennault's "Flying Tigers," who piled up the amazing 14-1 ratio against the Japs in China. Droppable gas tanks give added range. P-40's have done just about everything, including lugging 1,000-lb. bombs on racks below the fuselage.

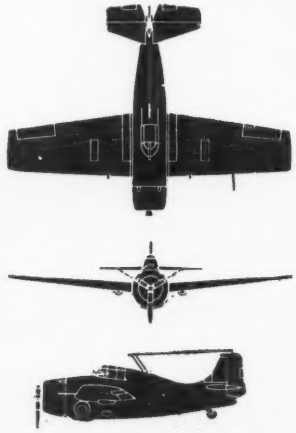
Span.....37 ft. 4 in.
Length.....33 ft. 4 in.
Height.....10 ft. 7 in.
High speed.....over 350 mph.
Normal range.....1,000 mi.
Gross wt.....9,000 lb.
Power.....one 1,150-hp. Allison



Douglas P-70

Fighter version of the famed A-20 *Havoc*, representing an adaptation of one of the most versatile aircraft in operation today. Principal difference in appearance is elimination of bombardier's enclosure in nose and substitution of faired-over section from which bristle four 20-mm. rapid-fire cannon. Although details have not been released, it is understood additional armament is provided besides the normal rear gunner's equipment.

Span.....61 ft. 4 in.
Length.....47 ft. 7 in.
Height.....17 ft. 7 in.
High speed.....over 325 mph.
Gross wt.....approx. 19,000 lb.
Power.....two 1,600-hp. Wrights



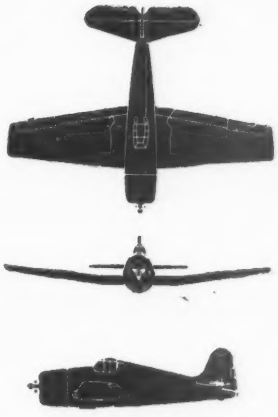
Grumman F4F-3 *Wildcat*

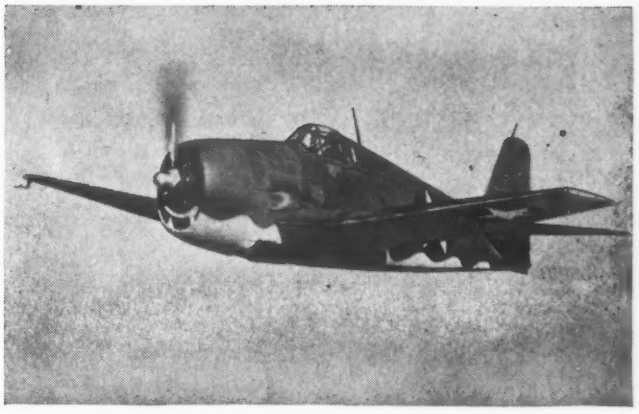
To date the most widely used carrier-based fighter in the world, this craft is also aboard flat-tops of the British, who call it the *Martlet*. It is also used extensively as a land-based fighter, especially by U. S. Marines in the South Pacific. Greatly resembles its successor-type, the F6F *Hellcat*. The F4F is also manufactured under license by Eastern Aircraft Div. of General Motors under the Navy designation FM-1.

Span.....38 ft.
Length.....28 ft. 11 in.
Height.....9 ft. 2 in.
High speed.....over 300 mph.
Normal range.....over 1,000 mi.
Weight empty.....6,100 lb.
Power.....one 1,200 hp. P & W.

Grumman F6f *Hellcat*

One of the few warplanes designed and put into production since we entered the war, the F6F has been called "the answer to a fighter pilot's prayer." No details have been released, but Navy says its 2,000-hp. Pratt & Whitney engine puts it "in the 400-mph. class" and is one of that service's "speediest, most maneuverable fighters." Although it looks much like the F4F, the *Hellcat* is larger and landing gear retracts into the wing rather than the fuselage. The F6F can be used either as a land- or carrier-based craft, and it is said to outfight the highly touted Jap *Zero* at any and all altitudes.

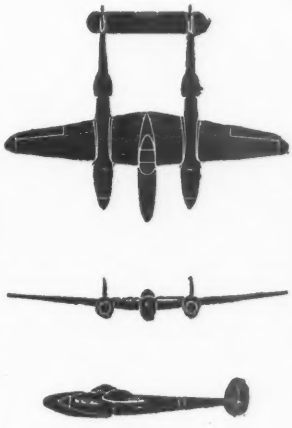




Lockheed P-38 *Lightning*

One of the world's fastest and most versatile craft, the P-38 has done everything from ground strafing and bombing to high altitude fighting and photo-reconnaissance. Its contra-rotating props—eliminating torque—and especially designed combat flaps give it exceptional maneuverability, especially for a plane of its size and weight. With droppable gas tanks, P-38's give fighter cover all the way to heavy bombers attacking Germany.

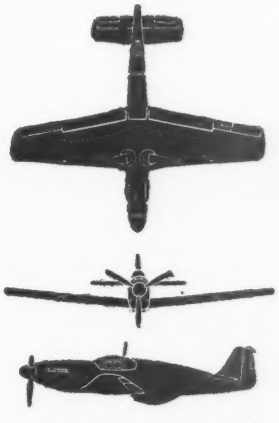
Span.....52 ft.
Length.....37 ft. 9 1/16 in.
Height.....9 ft. 10 1/4 in.
High speed.....over 400 mph.
Normal range.....750 mi.
Gross wt.....over 18,000 lb.
Power.....two 1,150-hp. Allisons.

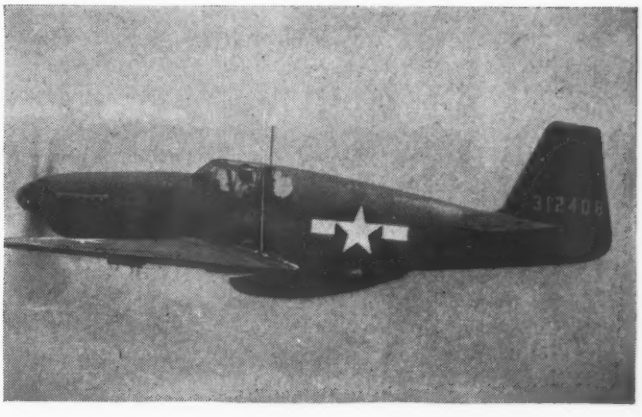


North American P-51B *Mustang*

Powered by the Packard-built Rolls Royce *Merlin XX* two-stage supercharged engine of 1,520 hp., the *Mustang* is generally accepted as one of the best fighters in the world. Outstanding characteristics include laminar flow wing and exceptionally narrow fuselage cross section. Armament varies between machine guns and cannon, and a dive bomber version, the A-36 *Invader*, has been used with great effectiveness throughout the Mediterranean campaign.

Span.....37 ft. 5/16 in.
Length.....32 ft. 5/8 in.
Height.....11 ft. 9 in.
High speed.....over 400 mph.
Service ceiling.....over 30,000 ft.
Gross wt.....approx. 10,000 lb.
Power....one Packard *Merlin XX*.



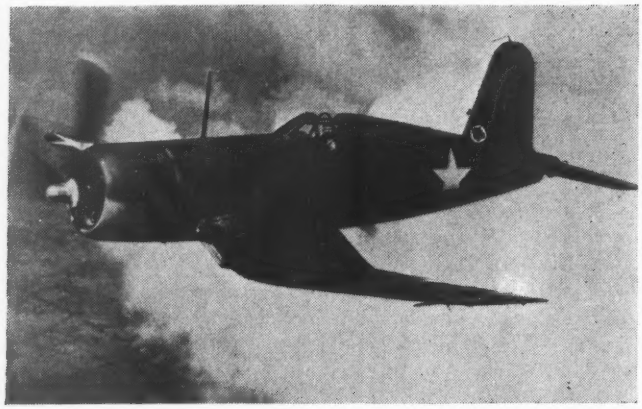


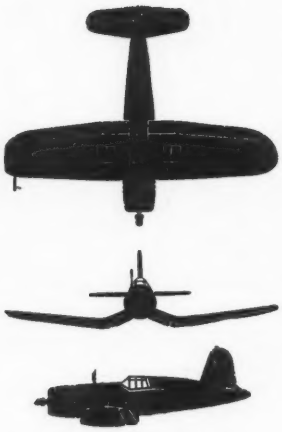
Republic P-47 *Thunderbolt*

Largest and heaviest single-engine fighter in the world, this Kartveli-designed craft, along with the Lockheed *Lightning*, provides fighter cover for 8th Air Force heavy bomber attacks on Nazi war production plants. Its turbosupercharger gets it above Nazi interceptors and, with its unmatched firepower, it has been consistently outfighting any and everything the Luftwaffe has had to pit against it.

Span.....40 ft.8 in.
Length.....36 ft. 1 in.
Height.....14 ft. 2 in.
High speed.....over 400 mph.
Gross wt.....13,500 lb.
Power...one 2,000-hp. turbosupercharged P & W.

American



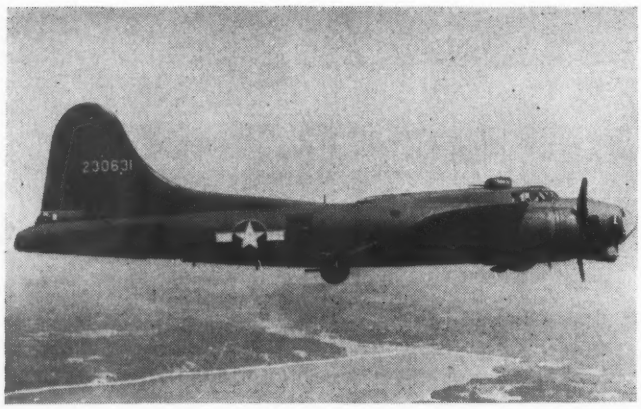


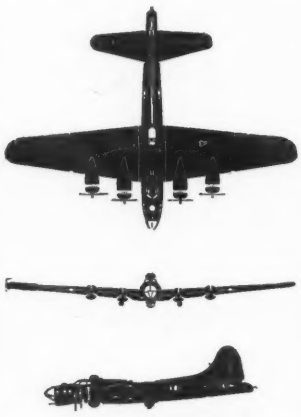
Vought F4U-1 *Corsair*

One of the Navy's two 2,000-hp. shipboard fighters, and another answer to the Jap *Zero*. Inverted gull wing design permits shorter landing gear while giving propeller clearance and increasing visibility. Heavily armed and armored, its ruggedness matches its performance. Also being manufactured under license by Goodyear Aircraft Corp. as the FG-1 and by Brewster Aeronautical Corp. as the F3A.

Span.....41 ft.
Length.....33 ft. 4 in.
Height.....16 ft. 1 in.
High speed.....over 400 mph.
Normal range.....over 1,500 mi.
Service ceiling.....over 35,000 ft.
Power.....one supercharged 2,000-hp. P&W.

Bombers

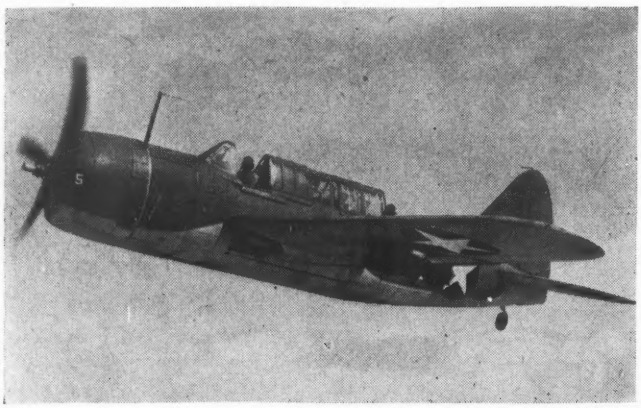


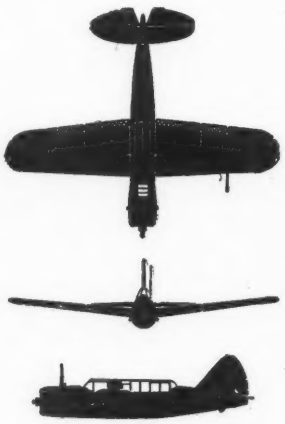


Boeing B-17G *Flying Fortress*

With its new chin turret bringing armament to a minimum of thirteen .50-cal. machine guns, this latest in the long series is more formidable than ever, both for shooting down enemy craft and in bomb load, with external racks bringing its destructive load capacity to a new high. Though its new "big brother," the B-29, is now in production, there is no indication the B-17 will be curtailed. Also manufactured by Douglas and Vega.

Span.....103 ft. 9 in.
Length.....74 ft. 9 in.
Height.....19 ft. 1 in.
High speed.....over 300 mph.
Normal range.....3,000 mi.
Gross wt.....65,000 lb.
Power.....four 1,200-hp. Wright *Cyclone* 9's.

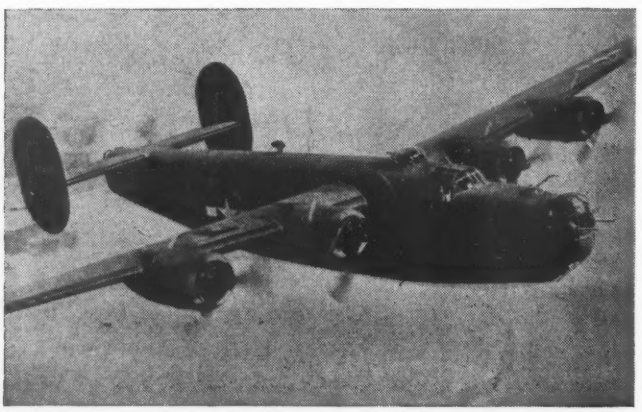




Brewster SB2A *Buccaneer*

A carrier-based dive bomber of conventional design, this craft is equipped with split trailing edge "swiss cheese" type (perforated) dive flaps. Most SB2A's are in service with the British as the *Bermuda*. Prototype model carried power gun turret in fuselage, a version which greatly resembled the Russian SU-2.

Span.....47 ft.
Length.....39 ft. 2⅜ in.
Height.....10 ft. 10 in.
High speed.....300 mph.
Normal range.....1,000 mi.
Gross wt.....13,150 lb.
Wt. empty.....9,976 lb.
Service ceiling.....27,000 ft.
Power.....one 1,700-hp. Wright *Cyclone* 14.



Consolidated Vultee B-24 *Liberator*

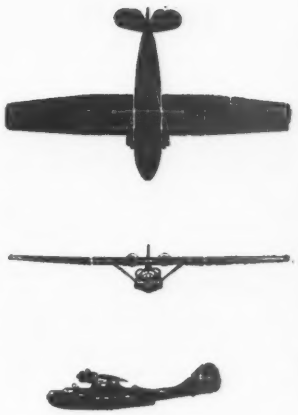
Already-heavy firepower has been increased through installation of a power turret in the nose, set just above bombardier's compartment, and a retractable ball turret set just aft of waist gunners' positions. Long in service with the RAF Coastal Command, "Libs" are now in the U.S. Navy too (PB4Y's), flying the grueling anti-submarine patrol.

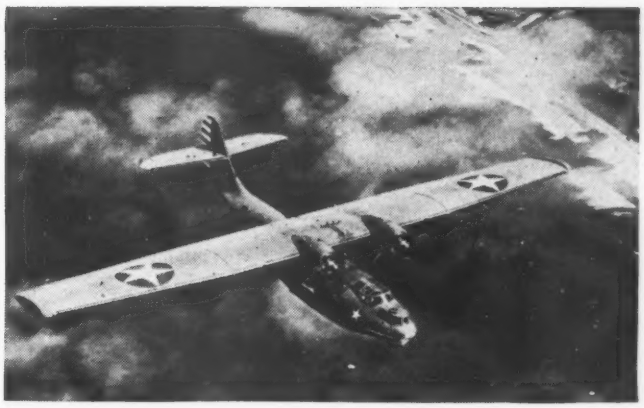
Span.....110 ft.
Length.....66 ft. 4 in.
Height.....17 ft. 11 in.
High speed.....over 300 mph.
Max. range.....over 3,000 mi.
Gross wt.....60,000 lb.
Power....four 1,200-hp. P & W's.

Consolidated Vultee PBY-5 *Catalina*

An old faithful of British as well as the American Navy, the "Cat" has been used for everything from reconnaissance through transport to torpedo bombing. Though comparatively slow by today's standards (they've been in service since 1936) *Catalinas* are still being built in large quantities. The PBY-5 is the amphibious version, with landing wheels retracting into sides of the hull.

Span.....104 ft.
Length.....63 ft. 11 in.
Height.....18 ft. 11 in.
Max. range.....3,100 mi.
Gross wt.....35,000 lb.
Power.....two 1,200-hp. P & W's.

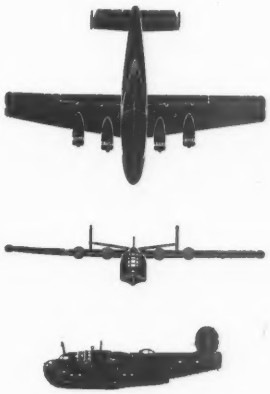


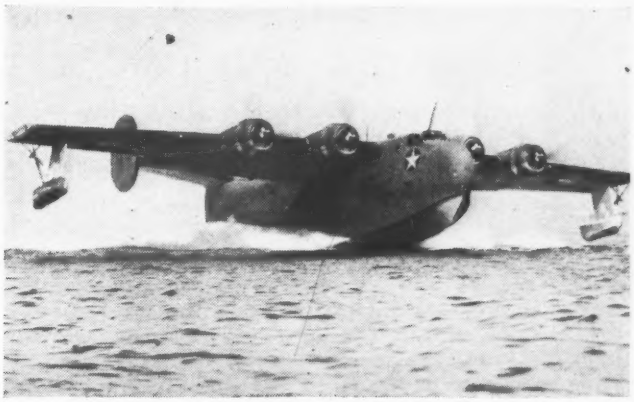


Consolidated Vultee PB2Y *Coronado*

Exceptionally long range patrol bomber, the *Coronado* also "doubles in brass" as a cargo carrier for Naval Air Transport Service. Until advent of the Martin *Mars*, it was largest flying boat in the Navy's service. Wing floats, like those of *Catalina*, retract up and out to form wingtips. Bomber version armament includes nose, dorsal and tail gun turrets.

Span.....115 ft.
Length.....79 ft. 3 in.
Height.....27 ft. 6 in.
High speed.....over 200 mph.
Max. range.....over 3,000 mi.
Gross wt.....66,000 lb.
Power....four 1,200-hp. P & W's.

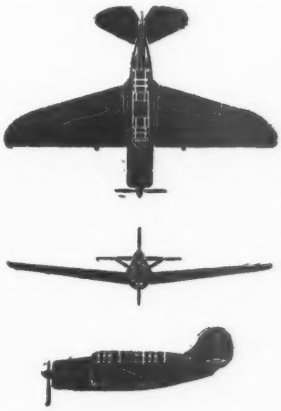




Curtiss SB2C *Helldiver*

Shipboard dive- or torpedo-bomber. One of largest, it carries bomb load of approximately 1,800 lb. within the fuselage. Also in production for the Army as the A-25 *Shrike*, equipped for skip, glide, or dive bombing. Dive and landing flaps are split trailing edge type. Armament consists of heavy caliber machine guns fixed in wings and in power turret firing to rear.

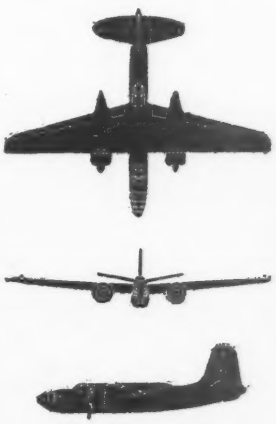
Span .....49 ft. 9 in.
Length.....36 ft. 8 in.
Height.....16 ft. 11 in.
High speed.....300 mph.
Cruising speed.....250 mph.
Service ceiling.....25,000 ft.
Power.....one 1,700-hp. Wright *Cyclone* 14.

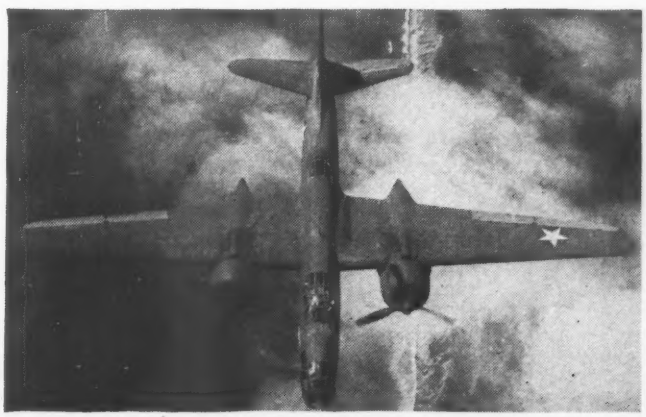


Douglas A-20 *Havoc*

One of the most versatile craft in the world, the A-20 has long been used by the British as the *Boston*, also is one of the favorites of the Russian Air Force. Has been used with great effect in skip bombing attacks as well as on torpedo bombing missions. Forward-firing armament varies greatly, but upper and lower guns in fuselage are standard equipment to ward off attack from rear. Also see AVIATION for Jan., 1943, page 125.

Span.....61 ft. 4 in.
Length.....47 ft. 3 in.
Height.....18 ft. 1 in.
High speed.....over 320 mph.
Gross wt.....19,750 lb.
Power.....two 1,700-hp. Wright *Cyclone* 14's.





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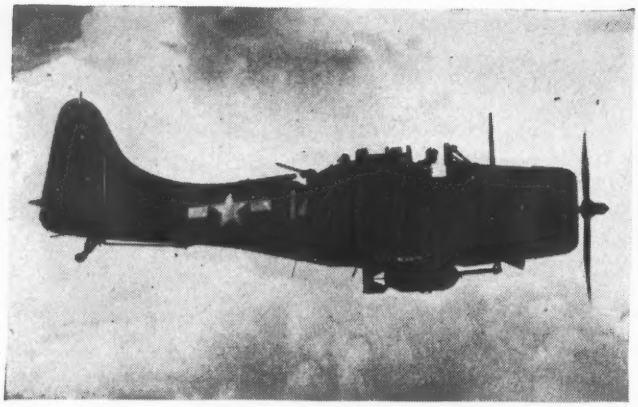
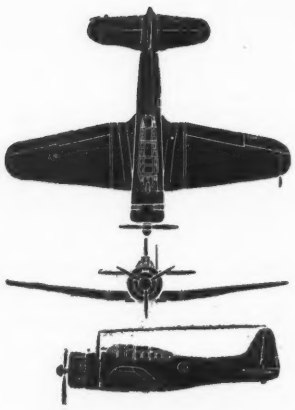
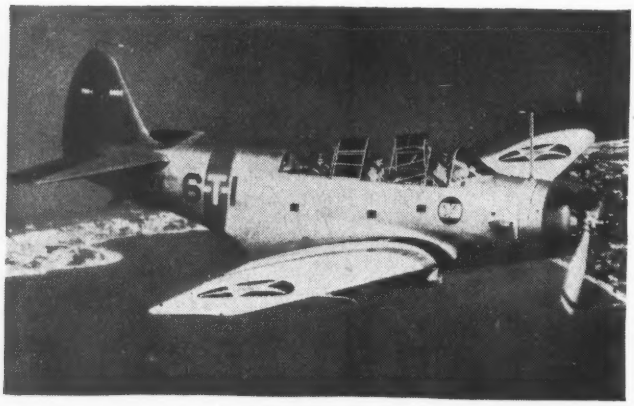


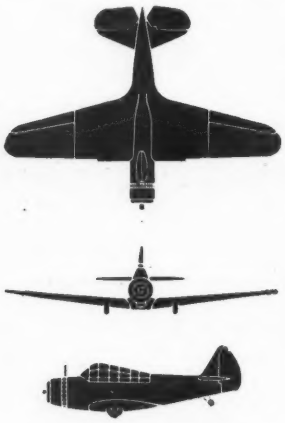


Douglas SBD *Dauntless*

A widely—and very successfully—used carrier-based dive bomber which has seen plenty of action with the Navy in the Pacific theater. A land-based version is also built for the Army as the A-24 *Banshee*. One 1,000-lb. bomb can be carried under the fuselage, or varying numbers of lighter bombs are mounted in racks under the wings.

Span.....41 ft. 6⅜ in.
Length.....32 ft. 8 in.
Height.....15 ft. 7 in.
High speed.....255 mph.
Cruising speed.....185 mph.
Gross wt.....9,519 lb.
Service ceiling.....25,200 ft.
Power.....one 1,000-hp. Wright *Cyclone* 9.

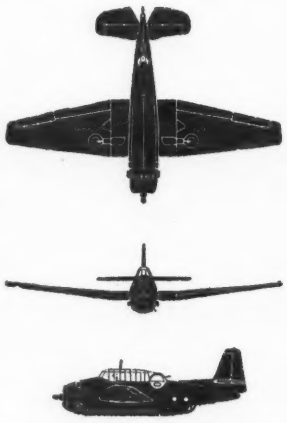




Douglas TBD *Devastator*

Now being succeeded by newer types, the TBD is retiring from combat with a record of honor compiled in the Battle of Midway and other important Naval engagements. Outer wing panels, which fold up and over fuselage for carrier operations, have corrugated skin similar to that employed on early Ford transports. All three crew members are housed under "camel's hump" greenhouse.

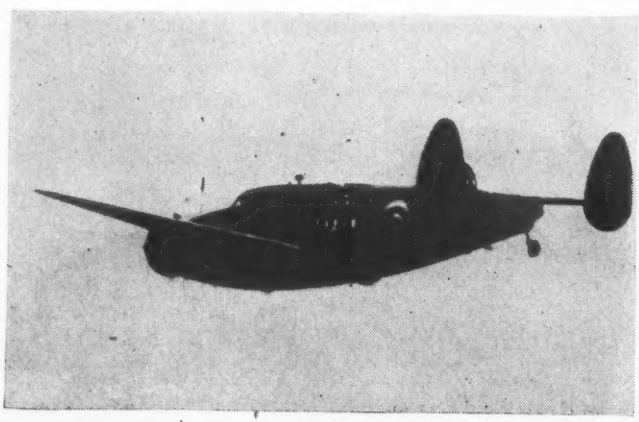
Span.....50 ft.
Length.....35 ft.
Height.....15 ft. 1 in.
High speed.....over 200 mph.
Service ceiling.....over 20,000 ft.
Normal range.....900 mi.
Gross wt.....9,300 lb.
Power..one 900-hp. P & W *Wasp Junior*.

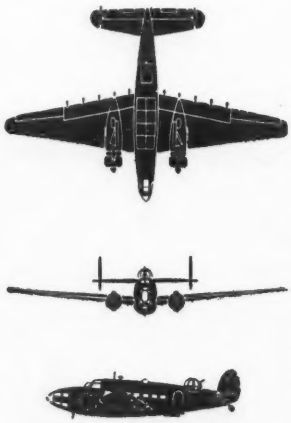


Grumman TBF *Avenger*

This plane, one of the largest carrier-borne craft in operation, carries a standard size torpedo within the fuselage. Like its fighter companion, the *Wildcat*, it is also widely used by the British. Carrying a crew of three, it has multiple machine guns firing forward, a dorsal power turret, and a ventral gun tunnel. From many angles it is difficult to distinguish from the *Wildcat* and *Hellcat*.

Span.....54 ft. 2 in.
Length.....40 ft.
Height.....16 ft. 5 in.
High speed.....over 250 mph.
Normal range.....over 1,000 mi.
Service ceiling.....over 20,000 ft.
Gross wt.....12,000 lb.
Power.....one 1,700-hp. Wright.





Lockheed A-29 *Hudson*

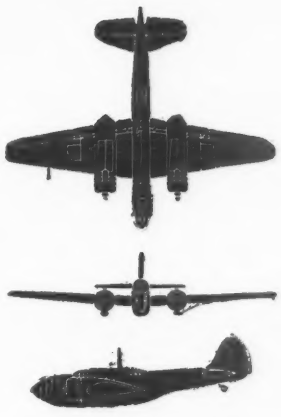
This medium bomber, one of the first craft to go into World War II with the British, earned the nickname "Old Boomerang" because it always seemed to get back from any type of mission. It also serves the Navy as the PBO and, without warpaint and some essential combat equipment, as the AT-18, an advanced Army gunnery trainer.

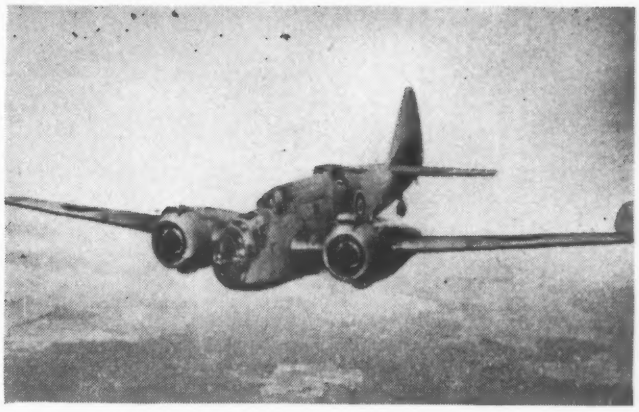
Span.....65 ft. 6 in.
Length.....44 ft. 4 in.
Height.....11 ft. 10½ in.
High speed.....275 mph.
Cruising speed.....246 mph.
Normal range.....2,000 mi.
Gross wt.....18,500 lb.
Power.....two 1,200-hp. P & W's.

Martin A-30 *Baltimore*

Another type to serve the British early in the war, the A-30—with its predecessor the A-22 Maryland—was used effectively as a spearhead for Gen. Sir Bernard Montgomery's 8th Army in its drive across Africa. It is used both as medium bomber and as low-level attack plane. In addition to forward firing machine guns, armament includes machine guns in dorsal and ventral positions.

Span.....61 ft. 4 in.
Length.....45 ft. 1 in.
Height.....17 ft. 8 in.
High speed.....over 300 mph.
Power.....two 1,600-hp. Wright *Cyclone* 14's.

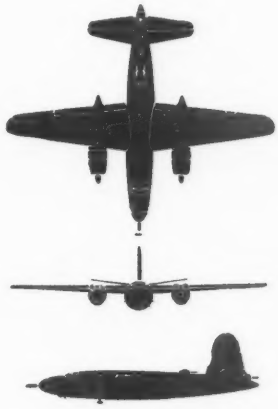




Martin B-26 *Marauder*

Rugged, heavily armed high performance medium bomber being used with increasing effectiveness against Nazi dominated Europe from American Air Force bases in England. Has also "doubled up" on over-water engagements as a torpedo bomber. Armament: .50-cal. machine guns in nose, tail, and power dorsal turret set in fuselage rear fin.

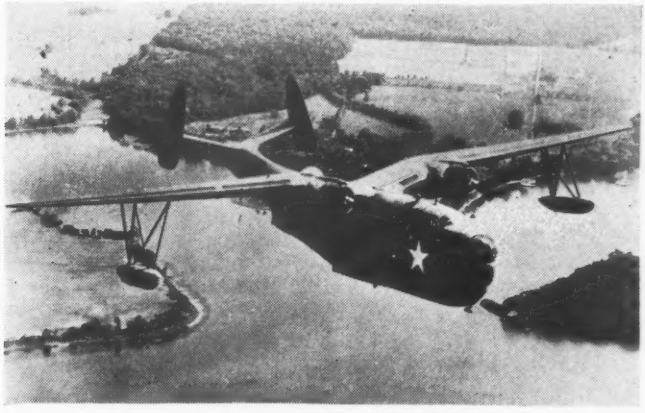
Span.....71 ft.
Length.....58 ft. 2 in.
Height.....21 ft. 6 in.
High speed.....over 300 mph.
Gross wt.....35,000 lb.
Power....two 2,000-hp. P & W's.



Martin PBM-3 *Mariner*

Long-range twin-engine patrol bomber extensively used for anti-submarine patrol as well as cargo lugging in version produced for that purpose. As patrol bomber, *Mariner* carries crew ranging up to twelve in number. Armament consists of heavy caliber machine guns in nose, dorsal, and tail turrets, plus side gun positions. Distinctive features: Gull wing and marked dihedral of stabilizer.

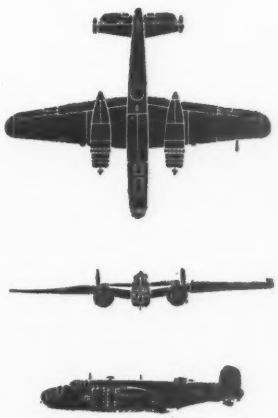
Span.....118 ft.
Length.....80 ft.
Height.....27 ft. 6 in.
High speed.....over 200 mph.
Normal range.....over 3,000 mi.
Service ceiling....over 15,000 ft.
Gross wt.....40,000 ft.
Power.....two 1,700-hp. Wright *Cyclone* 14's.



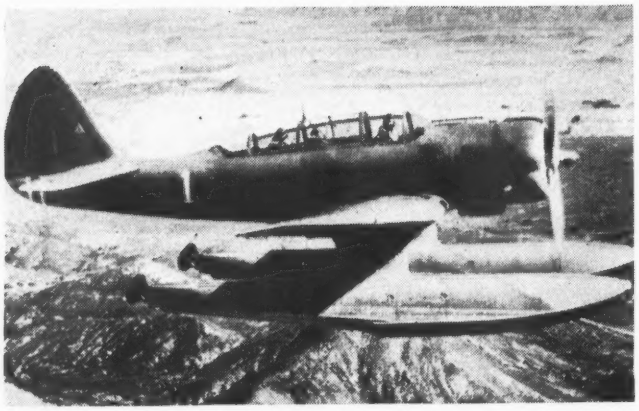
North American B-25 *Mitchell*

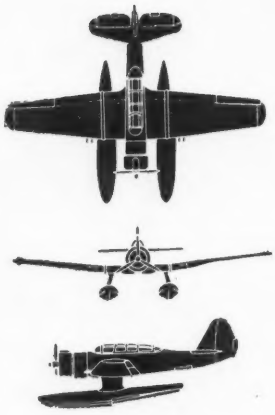
Having won its niche in the aircraft hall of fame as the plane which Gen. Jimmy Doolittle used in the first raid on Tokio, the B-25 now appears as true flying artillery, with a fast-firing 75-mm. cannon—plus machine guns—in the nose. Normal armament consists of .50-cal machine guns in nose, power turret amidships, and lower tunnel.

Span.....67 ft. 7 in.
Length.....51 ft. 11 in.
Height.....15 ft. 9 in.
High speed.....over 300 mph.
Cruising speed.....239 mph.
Gross wt.....over 35,000 lb.
Wt. empty.....20,306 lb.
Power.....two 1,700-hp. Wright *Cyclone* 14's.



American

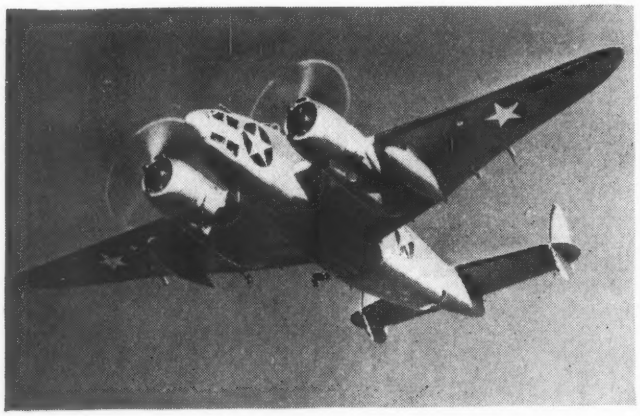


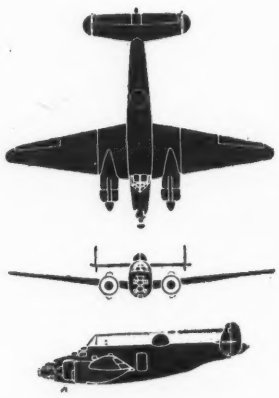


Northrop N-3PB

Low-wing, three-place patrol bomber, several of which are on duty along Swedish coast. Up to 2,000 lb. of bombs or one standard torpedo can be carried between the twin floats. Firepower consists of four .50-cal. machine guns mounted in the wings, a .30- or .50-cal. mounted in Scarff ring to cover top rear, and a similar size gun firing out fuselage bottom.

Span.....48 ft. 11 in.
Length.....36 ft.
Height.....12 ft.
High speed.....257 mph.
Cruising speed.....217 mph.
Normal range.....1,000 mi.
Gross wt.....10,600 lb.
Wt. empty.....6,190 lb.
Power.....one 1,100-hp. Wright *Cyclone*

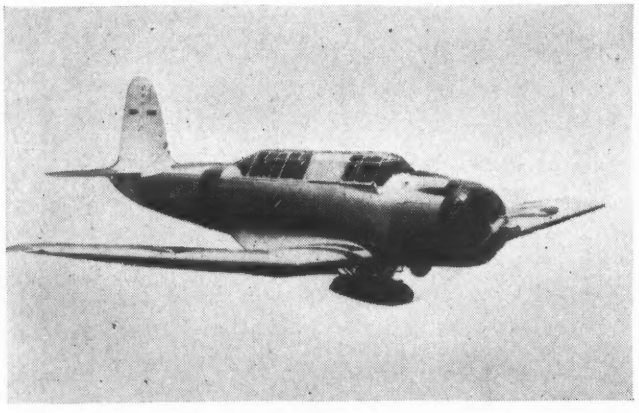


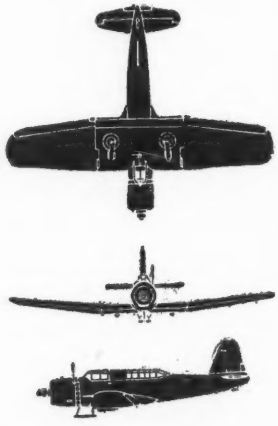


Vega B-34 *Ventura*

Worthy successor to the *Hudson*, the *Ventura*, bigger and faster, is widely used by the RAF for daylight attacks on Nazi-held northern Europe. A military development of the Lockheed *Lodestar* commercial transport, it carries a crew of four and mounts .50-cal. machine guns in the nose, ventral tunnel and powered dorsal turret. As the PV-1 it is taking an increasingly important part in the Navy's offshore anti-submarine patrol.

Span.....65 ft. 6 in.
Length.....51 ft. 5¼ in.
Height.....11 ft. 10½ in.
High speed.....over 300 mph.
Normal range.....1,000 mi.
Gross wt.....30,000 lb.
Power....two 2,000-hp. P & W's

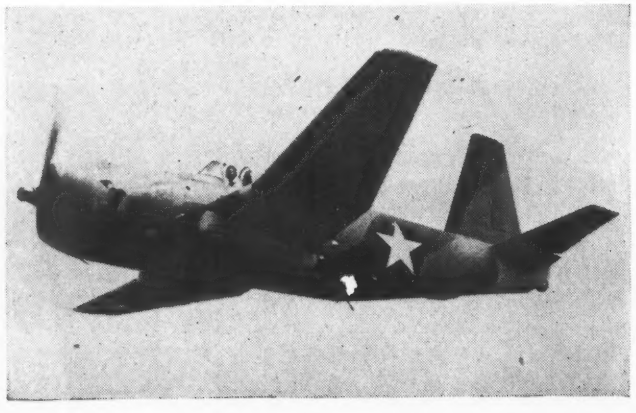


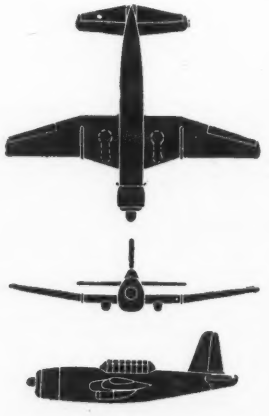


Vought-Sikorsky SB2U-3 *Vindicator*

Though now out of production, this craft is still in service as a dive bomber with both American and British fleets, the latter calling it the *Chesapeake*. Designed for carrier operation, it has folding wings. Unlike later types, the aft portion of the fuselage is welded steel tube construction, fabric covered.

Span.....42 ft.
Length.....34 ft.
Height.....9 ft. 10 in.
High speed.....257 mph.
Cruising speed.....227 mph.
Normal range.....700 mi.
Gross wt.....6,500 lb.
Power,..one 825-hp. P & W *Wasp Jr.*





Vultee A-35 *Vengeance*

All-metal low-wing dive bomber ordered by the British early in 1940, on which all production contracts have now been completed. Also used by the Navy as the TBV. Slatted dive brakes, flush with wing surfaces in normal flight, hinge outward from both top and bottom of wing for slowing dives on approach to target. Angular wing has unusual sweep-back only in center section.

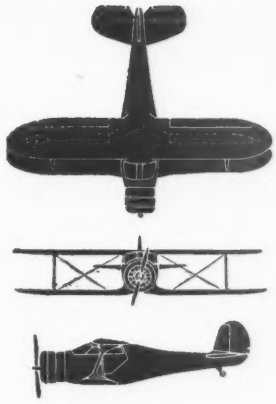
Span.....48 ft.
Length.....39 ft. 9 in.
Height.....13 ft. 7 in.
Power.....one 1,700-hp. Wright *Cyclone* 14

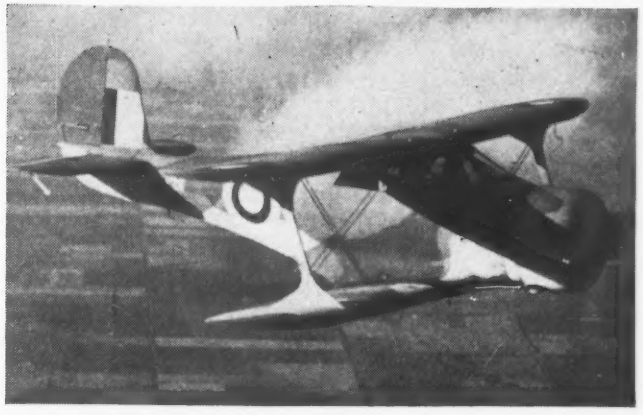
Cargo Transport

Beech C-43

One of the fastest peacetime private planes, this craft now serves Army as a personnel carrier. Perhaps the only biplane in such service, its outstanding feature is inverted stagger of upper and lower wings. It was one of earliest "personal" planes to be fitted with retractable landing gear.

Span.....32 ft.
Length.....26 ft. 1 in.
Height.....8 ft.
High speed.....203 mph.
Cruising speed.....171 mph.
Normal range.....525 mi.
Gross wt.....4,250 lb.
Service ceiling.....24,300 ft.
Power.....one 450-hp. P & W.

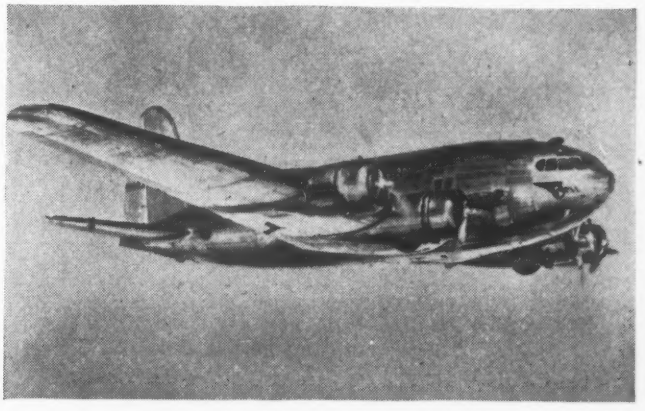




Boeing 307 *Stratoliner*

A peacetime luxury liner pressed into war service and operated on foreign routes under contract for the AAF Air Transport Command. Produced for commercial operation in the substratosphere, its spacious 38-passenger cabin was designed for pressurization to maintain 8,000-ft. altitude pressure. Note typical long, Boeing vertical fin, similar to that on B-17 *Flying Fortress*.

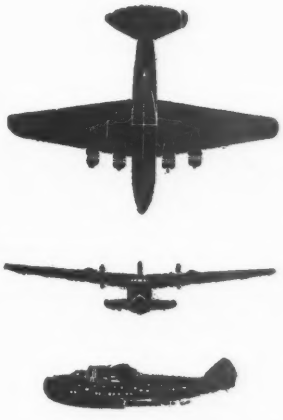
Span.....107 ft. 3 in.
Length.....74 ft. 4 in.
Height.....20 ft. 10 in.
High speed.....250 mph.
Cruising speed.....222 mph.
Normal range.....1,675 mi.
Fuel capacity.....1,700 gal.
Gross wt.....45,000 lb.
Wt. empty.....30,000 lb.
Power.....four 1,100-hp. Wrights.

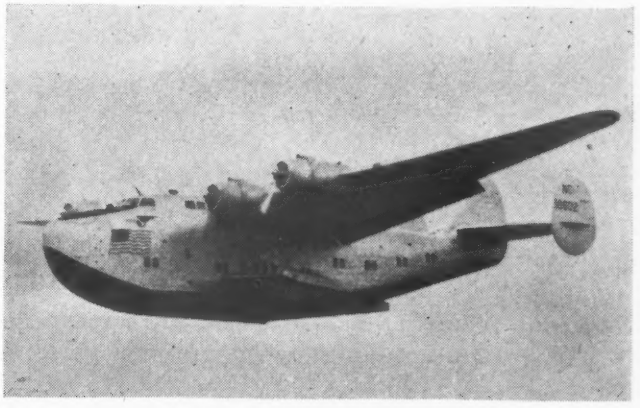


Boeing 314 *Clipper*

Famed for prewar commercial service between America and England, some of this type have been turned over to the British, for whom they are operated by British Overseas Airways, England's government-operated wartime service. Those still flying the U. S. flag are commercially operated.

Span.....152 ft.
Length.....106 ft.
Height.....20 ft. 10 in.
High speed.....210 mph.
Cruising speed.....188 mph.
Max. range.....4,900 mi.
Gross wt.....84,000 lb.
Wt. empty.....49,149 lb.
Power.....four 1,600-hp. Wright *Cyclones*.

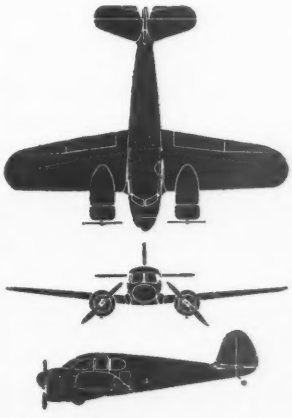


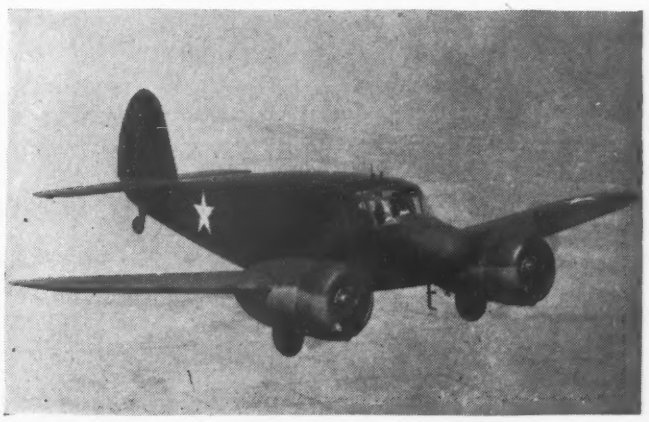


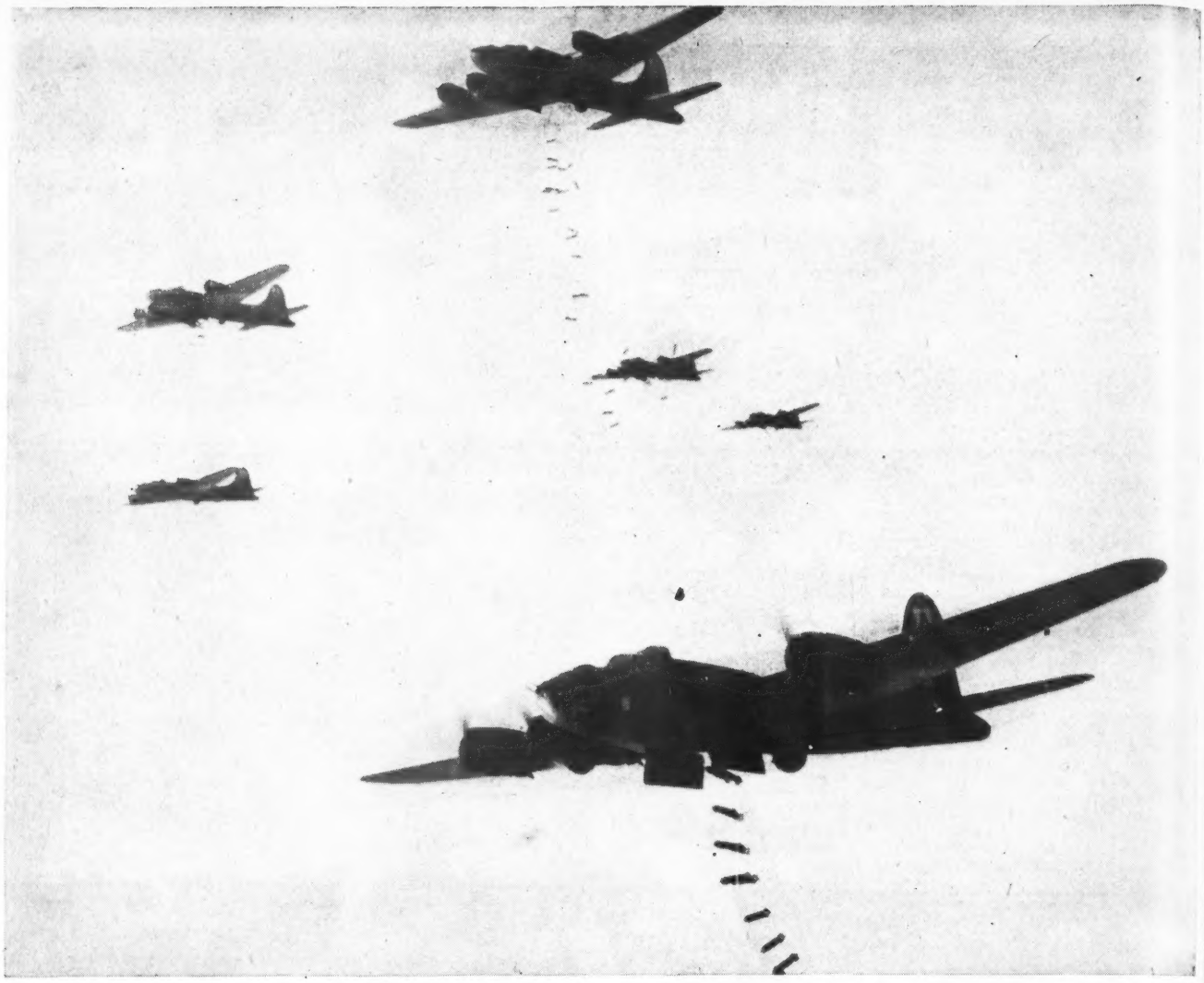
Cessna UC-78

Basically this is famed Cessna AT-17 *Bobcat* advanced trainer design adapted to personnel carrier work. A five-place craft, it relieves larger transports for cargo or troop carrying service, but still gives speed necessary for war operations, since it cruises at 155 mph. As the *Crane*, this type has been delivered in large quantities to the Royal Canadian Air Force.

Span.....41 ft. 11 in.
Length.....32 ft. 9 in.
Height.....10 ft.
High speed.....175 mph.
Cruising speed.....155 mph.
Normal range.....490 mph.
Gross wt.....5,700 lb.
Wt. empty.....4,054 lb.
Power.....two Jacobs L-4MB's.







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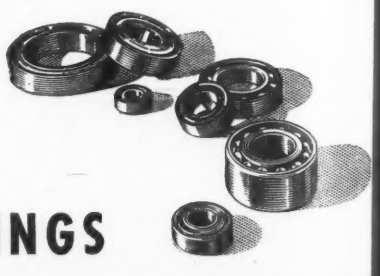
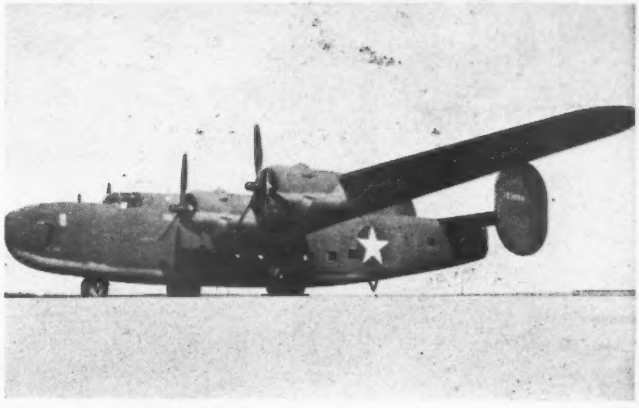


NEW DEPARTURE BALL BEARINGS

Consolidated Vultee C-87 *Liberator Express*

This transport, one of initial conversions from a bomber type, is the cargo-passenger version of the B-24 *Liberator*, mass-produced at Convair's Fort Worth, Tex., plant. Many of Prime Minister Churchill's world-wide conferences have been reached in one of the first C-87's to come off the line, and Wendell Willkie's globe-girdling trip was also made in an *Express*.

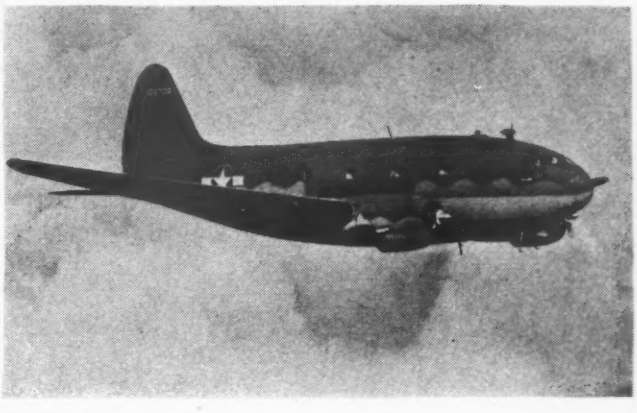
Span.....110 ft.
Length.....66 ft. 4 in.
Height.....17 ft. 11 in.
High speed.....over 300 mph.
Max. range.....over 3,000 mi.
Gross wt.....60,000 lb.
Wt. empty.....31,330 lb.
Power....four 1,200-hp. P & W's.



Curtiss C-46 *Commando*

Largest twin engine cargo transport in production, *Commando* is serving on all fronts. Equipped to carry either paratroops or cargo such as light artillery, jeeps, engines, etc., it is quickly convertible to a hospital craft, with capacity for 33 litters. Also see AVIATION for August, 1943, page 130.

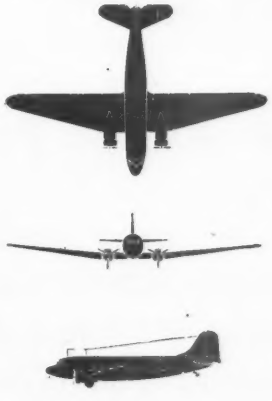
Span.....108 ft. 1 in.
Length.....76 ft. 4 in.
Height.....21 ft. 9 in.
High speed.....265 mph.
Cruising speed.....227 mph.
Service ceiling.....over 24,500 ft.
Gross wt.....45,000 lb.
Wt. empty.....29,483 lb.
Power....two 2,000-hp. P & W *Twin Row Wasps*.

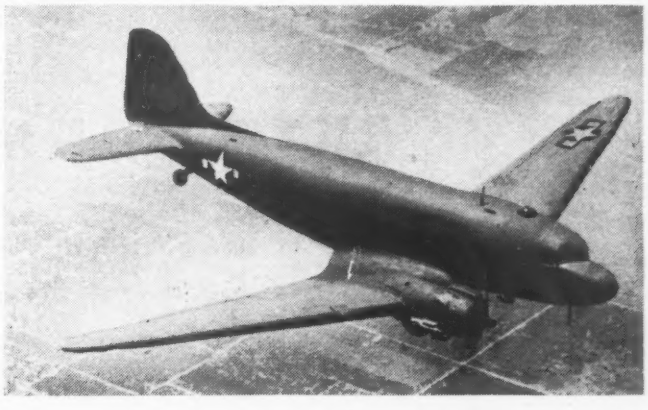


Douglass C-47 *Skytrain*

Wartime version of the old reliable DC-3, "workhorse of the air." Back-bone of the Air Transport and Troop Carrier Commands, this type is familiar in all parts of the world. More than 2,000 have been produced by one Douglas plant alone since Pearl Harbor. C-49, called *Skytrooper*, is used primarily for paratroops.

Span.....95 ft.
Length.....64 ft. 5½ in.
Height.....16 ft. 11⅛ in.
High speed.....230 mph.
Cruising speed.....185 mph.
Normal range.....over 2,000 mi.
Gross wt.....29,000 lb.
Wt. empty.....16,970 lb.
Power....two 1,050-hp. P & W's.

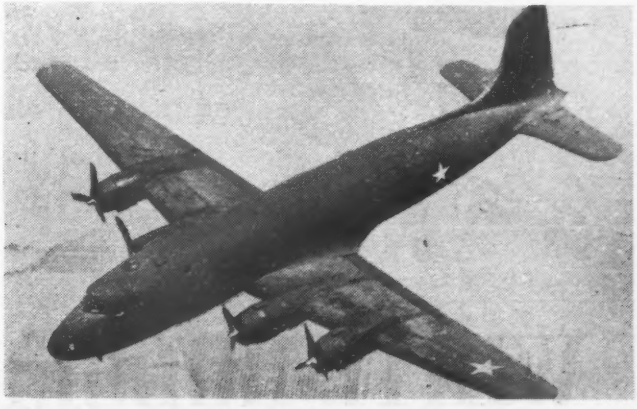




Douglas C-54 *Skymaster*

Developed from the DC-4, this four-engine cargo-transport is serving the Army on more than one transocean route. Retractable tricycle landing gear employs paired wheels at all three points. Although widely used as a passenger transport, its cargo volume capacity—which approximates that of a standard box car—makes it a favorite for hauling loads both bulky and heavy.

Span.....117 ft. 6 in.
Length.....93 ft. 10 in.
Height.....27 ft. 6⅝ in.
High speed.....285 mph.
Cruising speed.....222 mph.
Max. range.....over 3,000 mi.
Gross wt.....66,000 lb.
Power....four 1,100-hp. P & W's.



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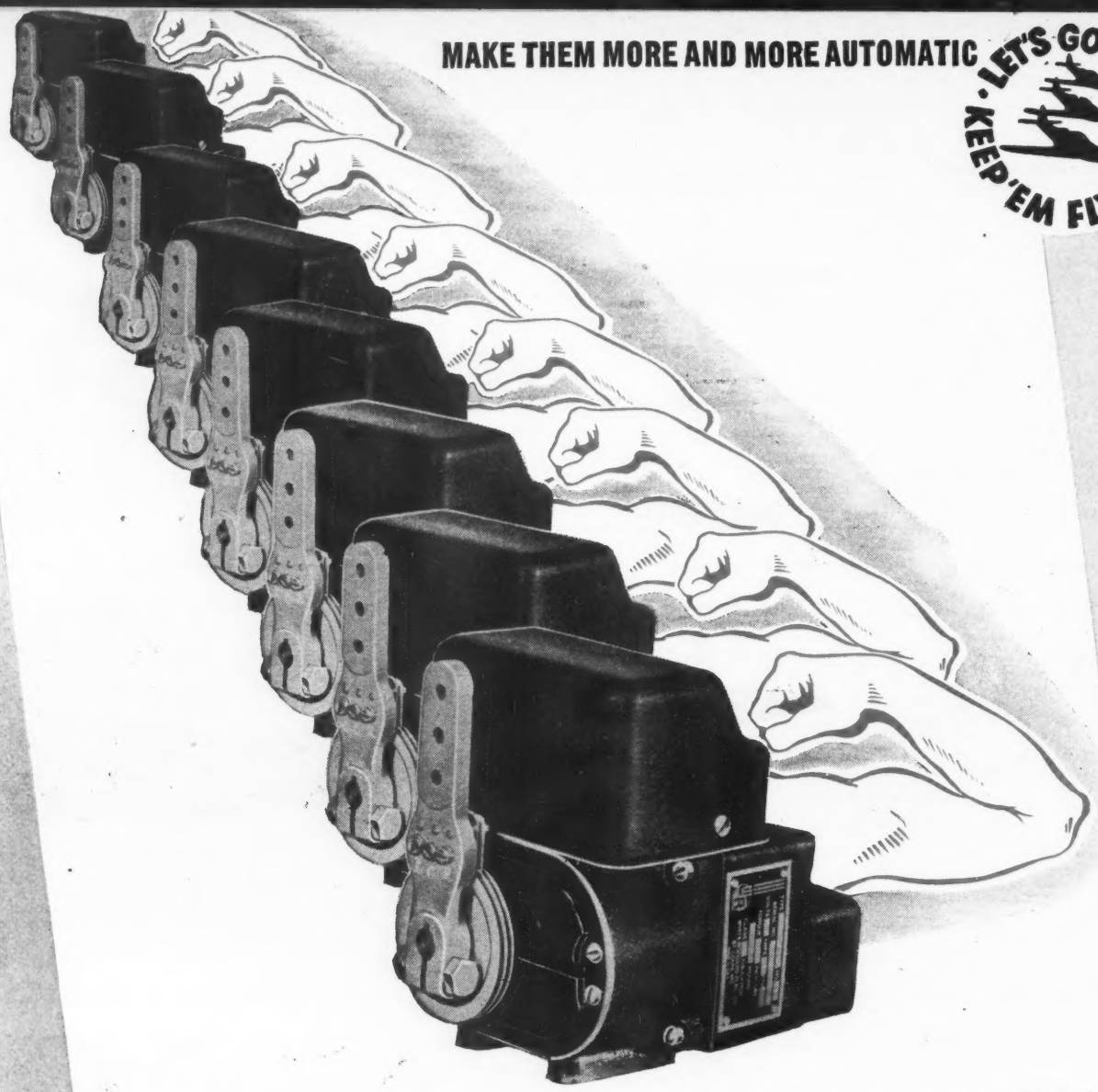

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Engineering data will be furnished to manufacturers on request.

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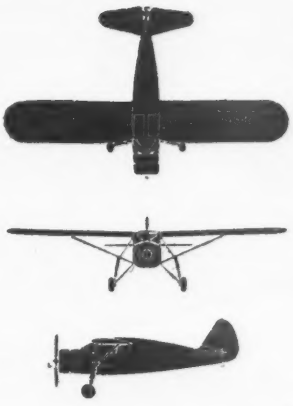
Fairchild UC-61A *Forwarder*

One of the best-known peacetime personal planes—large numbers of which immediately went on duty with Civil Air Patrol—serving the Army as a personnel and light cargo carrier. Some have also been equipped for blind flight instruction. With Civil Air Patrol has been operated on both anti-submarine patrol and courier service.

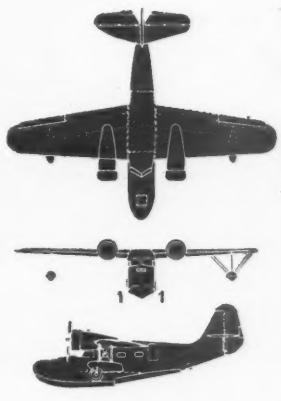
Span.....36 ft. 4 in.
Length.....23 ft. 10 in.
Height.....7 ft. 7½ in.
High speed.....110 mph.
Cruising speed.....104 mph.
Normal range.....555 mi.
Gross wt.....2,801 lb.
Wt. empty.....1,732 lb.
Power.....one 165-hp. Warner



Grumman JRF-6B Goose

A military development of the company-designated G-21A commercial amphibian. Used largely by the Coast Guard for inshore patrol and, during peacetime as well, rescue work. An all-metal craft, the hull is of aluminum alloy monocoque construction.

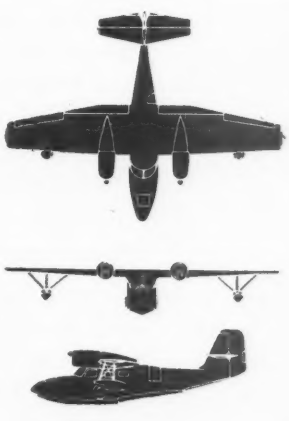
Span.....49 ft.
Length.....38 ft.
Height.....12 ft.
High speed.....201 mph.
Cruising speed.....190 mph.
Normal range.....1,000 mi.
Service ceiling.....22,000 ft.
Gross wt.....7,955 lb.
Wt. empty.....5,530 lb.
Power.....two 450-hp. P & W *Juniors*.

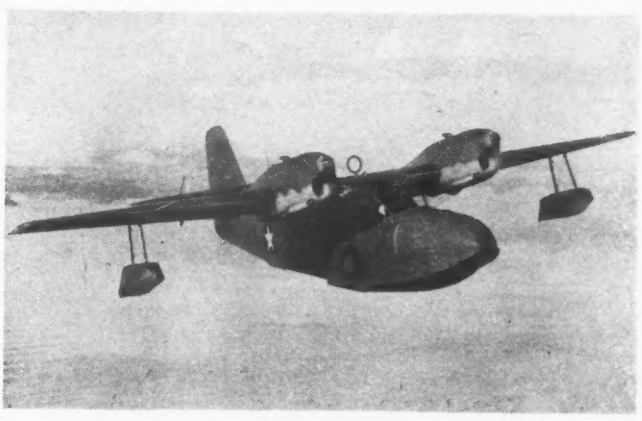


Grumman J4F-1 *Widgeon*

A smaller teammate to the Grumman *Goose*, the *Widgeon* was developed from the G-44. It is a 4-5 place craft, compared with the *Goose*' 8-passenger capacity. It is used extensively by the Coast Guard for patrol and rescue work as well as personnel and light cargo transport. Landing gear, which in extended position has a 90-in. tread, retracts against side of hull.

Span.....40 ft.
Length.....31 ft.
Height.....9 ft.
High speed.....165 mph.
Normal range.....775 mi.
Gross wt.....4,500 lb.
Wt. empty.....3,050 lb.
Power.....two 200-hp. Rangers.





Lockheed C-60 *Lodestar*

Military transport version of the famed commercial model of the same name. Several of the type have also been modified to serve as avigation training classrooms. A 14-place plane, the C-60's high speed makes it a favorite for passenger transport work.

Span.....65 ft. 6 in.
Length.....49 ft. 9⅞ in.
Height.....11 ft. 10½ in.
High speed.....276 mph.
Cruising speed.....248 mph.
Normal range.....1,540 mi.
Service ceiling.....27,000 ft.
Gross wt.....18,500 lb.
Power....two 1,200-hp. P & W *Wasps* or two 1,200-hp. Wright *Cyclones*.

Appointment at Seven ... SEVEN MILES ... UP!

Seven miles or more above Nazi earth a big, barrel-chested, brutal-looking fighter plane has an appointment with a Focke-Wulf. This appointment was written down in the engagement book of the Army Air Forces a long time ago, *before we had a fighter plane that could work effectively at 35,000-40,000 feet.*

Keeping this appointment is—the P-47 Thunderbolt!

... escorting heavy bombers on raids deep into Europe ... rolling up combat scores of 2 to 1, 4 to 1, even 15 to 1 against Germany's best fighters.

In designing a six-ton stratosphere fighter, Republic Aviation solved many long-standing problems in the field of high speed, high altitude aircraft. After the war, long distance commercial planes will fly more safely, more swiftly, more economically—because they'll fly *high*. Republic Aviation Corporation, Farmingdale, L. I., N. Y. and Evansville, Ind.

REPUBLIC AVIATION CORPORATION

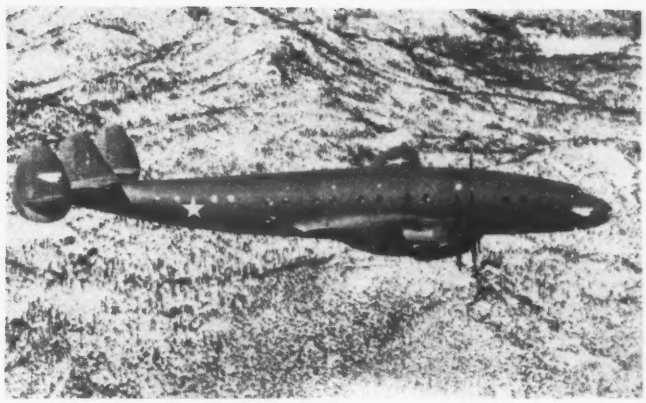
FARMINGDALE DIVISION

SPECIALISTS IN HIGH-SPEED AIRCRAFT · *MAKERS OF THE* **Thunderbolt**

Lockheed C-69 *Constellation*

Originally designed as a luxury liner capable of crossing the United States in "less than 9 hr.", an accelerated production program means large numbers are going into military transport service. Though little data has yet been released, it is reported the plane exceeded all expectations on test flights. Wing design incorporates many features found in the Lockheed P-38 *Lightning* fighter, and Lockheed-Fowler flaps keep landing speed exceptionally slow for a craft of its size.

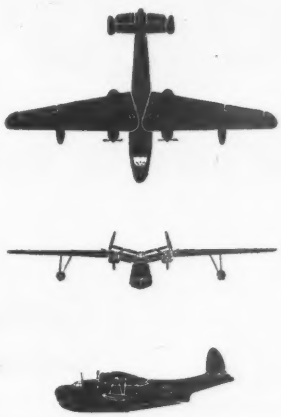
High speed.....over 350 mph.
Power.....four 2,200-hp. Wright *Cyclone* 18's.



Martin PBM-3 *Mariner*

Cargo-lugging version of the long-range patrol bomber of same name. Principal difference in appearance is faired-over nose brought with removal of gun turret, also elimination of dorsal power gun turret. It is being operated by commercial airlines under contract with Naval Air Transport Service, which today operates some 50,000 mi. of global airways.

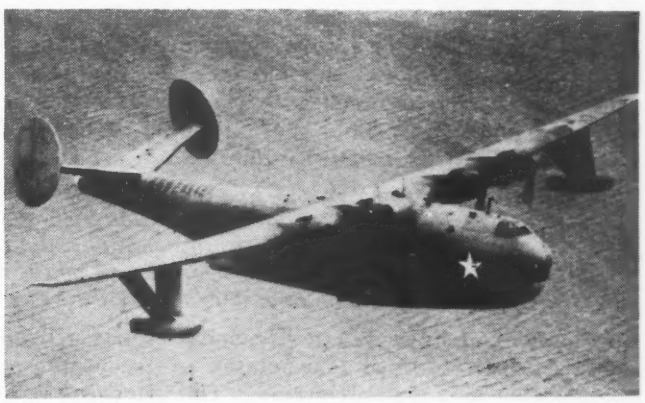
Span.....118 ft.
Length.....80 ft.
Height.....27 ft. 6 in.
High speed.....over 200 mph.
Normal range.....over 3,000 mi.
Service ceiling.....over 15,000 ft.
Gross wt.....40,000 lb.
Power.....two 1,700-hp. Wright *Cyclone* 14's.



Martin XPB-2M *Mars*

Conceived originally as a long-range patrol bomber, the need for air transport brought its conversion to that service. On its first war mission, this twin-deck craft—with a volume capacity equal to that of 15-room house—carried up to 35,000 lb. of cargo. On this trip it covered 8,972 mi. in one jump at an average speed of 161 mph. On another run average speed was 177 mph.

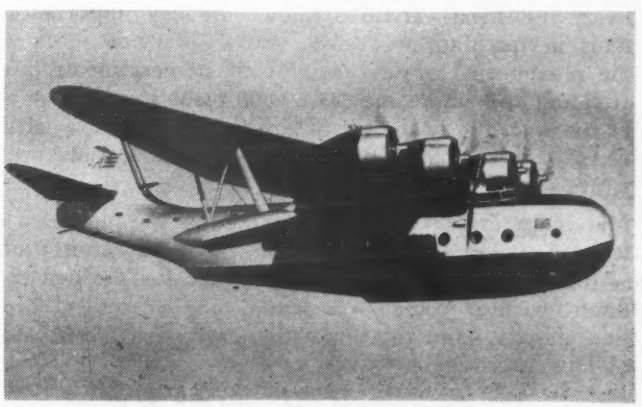
Span.....200 ft.
Length.....approx. 190 ft.
High speed.....over 200 mph.
Gross wt.....148,500 lb.
Wt. empty.....74,600 lb.
Power.....four 2,200-hp. Wright *Cyclone* 18's.



Vought-Sikorsky VS-44A *Excalibur*

Designed and built for commercial transatlantic work, this craft went into service with American Export Air Lines just before the war. Many details of its design and construction have been presented in AVIATION's Sketch Book of Design Detail.

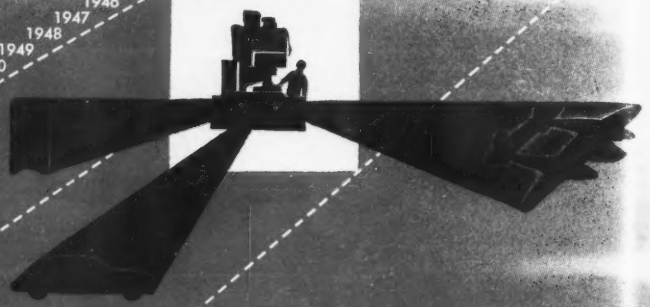
Span.....124 ft.
Length.....79 ft. 3 in.
Height.....24 ft. 7 in.
High speed.....225 mph.
Cruising speed.....175 mph.
Max. range.....3,800 mi.
Gross wt.....57,500 lb.
Power.....four 1,200-hp. P & W *Twin Wasps.*



What will your future I.P. be?

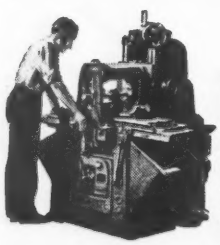
This is the First of a series of advertisements presenting "Industrial Par" and its importance to your company in all future planning. Save this and succeeding I.P. advertisements as the basis for discussion and as a guide to your planning program.

1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964



50% increased output per man-hour every 10 years

Will your production make this National †† Industrial Par



RESEARCH reveals that in the 12 years, 1929-1941, the nation's output per man-hour increased 34%. The rate is 2½% per year compounded. And there is ample evidence accumulating that the rate will advance to at least 4%. War — the supreme national productive effort it calls for — accelerates man-hour output. Improved production techniques — developed in war — carry over into peacetime; the pent-up buying power released after Victory will tremendously stimulate production.

Thus manufacturers who intend to keep step with a high level of national prosperity — the volume production which means more goods for more people at lowest cost, and security of jobs and wages for the greatest number of workers — must strive to increase their output per man-hour 50% every 10 years.

To put it another way, American industry sets a definite national industrial PAR for man-hour output or production — 4% compounded per year rate of increase. The management of your company can determine its own competitive standing in terms of its ability to make or break this PAR.

Every industrial executive knows the key importance of machine tools in reaching production goals. Machine tools were basic to the phenomenal achievement of the American aircraft industry in attaining and surpassing the 60,000 plane quota set at the beginning of the war. The majority of the war industries — all machine tool users — were able to produce at a rate far in advance of the timetables set for them.

Manufacturing for peacetime markets is as much of a challenge as manufacturing for war. To make better products — faster — at lower cost — will call for the newest and finest machine tools — essential implements of production efficiency and the increased output that means security of jobs and wages.

Back the attack **BUY MORE BONDS**

Spotlight facts for your future I.P. *planning*

* Production methods — developed in wartime —increase man-hour output; pent-up buying power — released in peacetime — demands increased production.
* The rate of 2½% increase per year output per man-hour, established by a 12 year record of industrial production, can be expected to reach at least 4% per year — compounded.
* Manufacturers must set a goal of 50% increased output per man-hour every 10 years — to maintain a high level of national prosperity and achieve its benefits in terms of security of jobs and wages for the greatest number of workers and the volume production of more goods for more people at lowest cost.
* Machine tools — the most modern, most efficient — are recognized as the most effective implements of mass production and increased output at lowest cost — but only continual replacements with the newest and finest machine tools assures full productive capacity. *Such replacements yearly should be equal to 10% of the total machine tool investment — in keeping with increased output.*
* The cost of machine tools is insignificant in terms of their productive power . . . from 1927 to 1937, according to census reports American manufacturers had only a total of about 2% invested yearly in machine tools in ratio to a total volume of 9 billion dollars worth of production annually.

†† **Industrial Par** — *the constantly increasing output per man-hour equal to approximately 50% every 10 years.*

KEARNEY & TRECKER CORPORATION

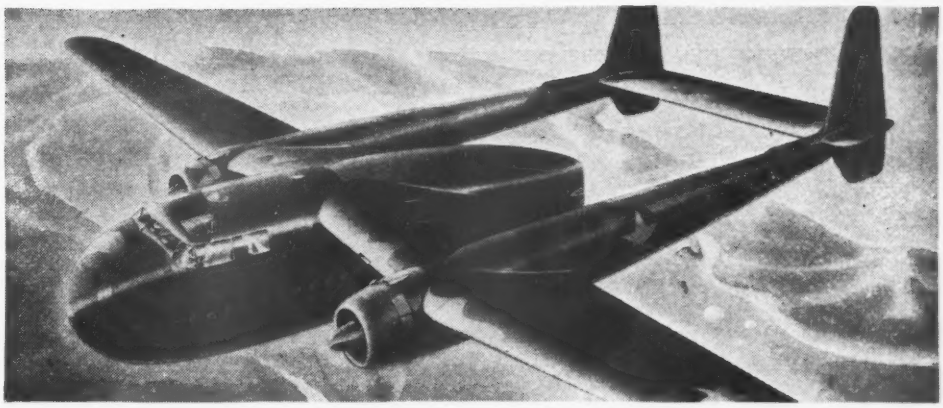
MILWAUKEE 14 WISCONSIN

Milwaukee Machine Tools

American

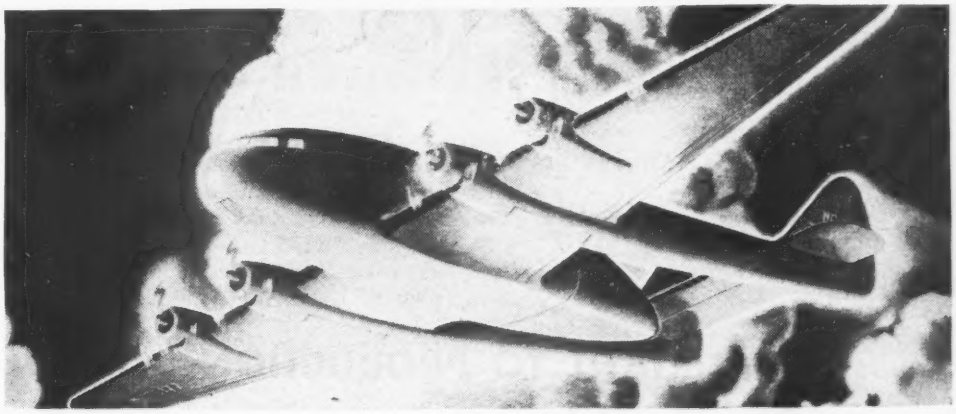
Fairchild C-82

Soon to undergo test flights is this completely new Fairchild-designed cargo-paratroop transport. The twin boom construction makes it possible to put both loading and paratroopers' doors in aft end of fuselage completely unencumbered by the empennage. Landing gear is so designed that craft is in level position on the ground and fuselage floor is just at truck-body level to facilitate loading. No specifications have been released, but it is stated that plane is expected to have a range of better than 3,000 mi. and that it will be all metal.



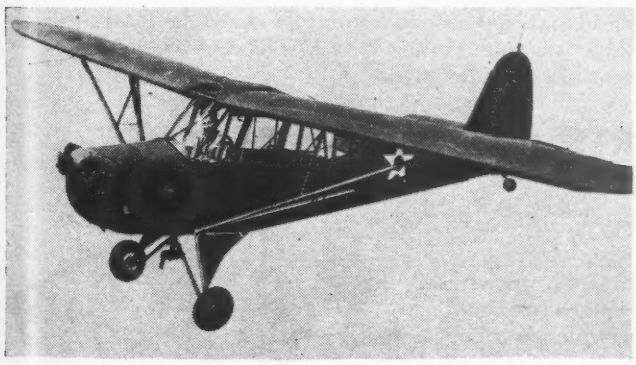
Martin Postwar Transport

A basic design adaptable to either two- or four-engine types, this craft is still in the engineering stage. Both types will utilize tricycle landing gear, and in both cases aft end of fuselage will open out and up. Hydraulic unit which opens fuselage will also lower loading ramp, either to ground or to truck level. Self-contained winch will facilitate loading without depending on field facilities. Both two- and four-engine versions have empennage mounted on booms, leaving fuselage clear for loading. Design of two-engine version calls for gross weight of 60,000 lb., and the four-engine of 86,000 with a useful load of 36,870 lb., of which 27,000 lb. would be cargo.

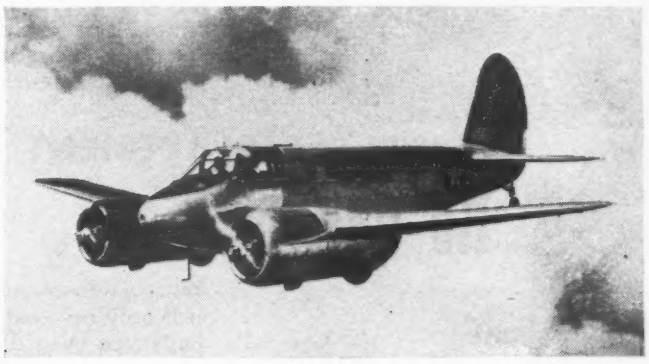


For complete specifications see page 235

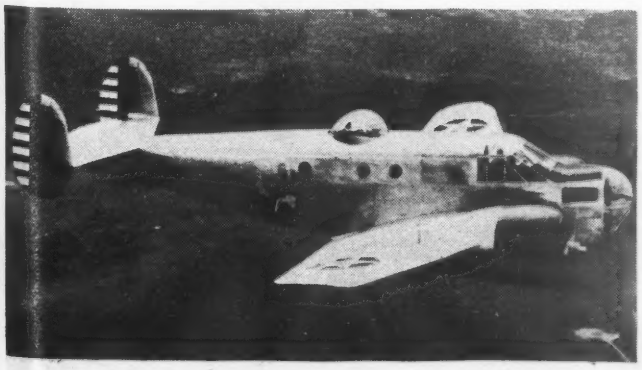
Liaison — Trainers — Observation



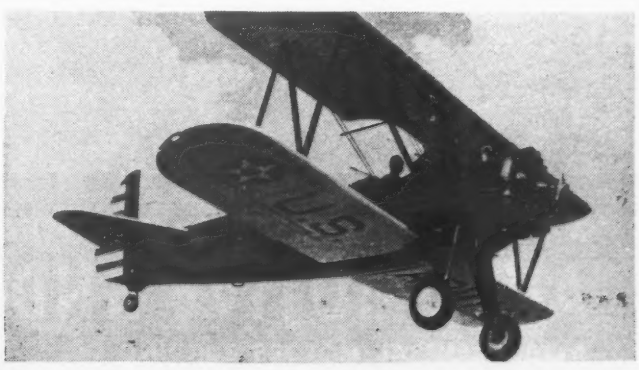
Aeronca L-3B



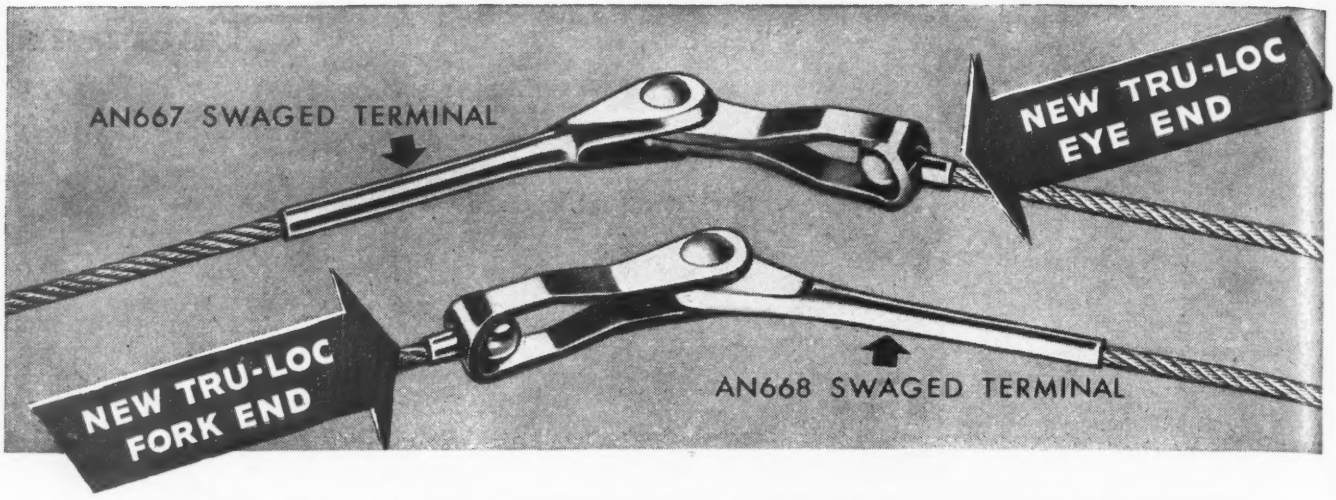
Beech AT-10 *Wichita*



Beech AT-11 *Kansas*



Boeing PT-17 *Kaydet*



NEW TRU-LOC TERMINALS THAT ARE EXACTLY Interchangeable WITH AN667 AND AN668

You can use the many advantages of this new development in Aircraft Terminals without any change in control engineering. Strength characteristics, operating qualities and dimensions are so equalized with AN667 and AN668 that it is perfectly sound to replace completely with the new TRU-LOC Terminals. It makes absolutely no difference, either whether service replacement parts are AN667 and AN668, or the new TRU-LOC Terminals.

IMPORTANT TO PRODUCTION SCHEDULES—THEY ARE Obtainable *NOW*, REDUCING DELAYS

Equipment is available for producing Strap Type End Fittings in unlimited quantities. Time and material needed to produce the Ball•Type Swaged Fittings are notably less than required for AN667 and AN668. These are important war-time considerations.

LOWERS REPLACEMENT PARTS INVENTORY BECAUSE Re-Usable

When cable assemblies must be renewed, it is only necessary to replace the small ball•type swaged fitting which is much more easily swaged than AN667 or AN668. The strap fitting is re-usable.

Exact data, including complete dimensional tables are given in this 6-page, 8 ½" x 11" folder, "AIRCRAFT TERMINALS DATA." *Write for a copy.*

TRADE MARK ACCO

In Business for Your Safety

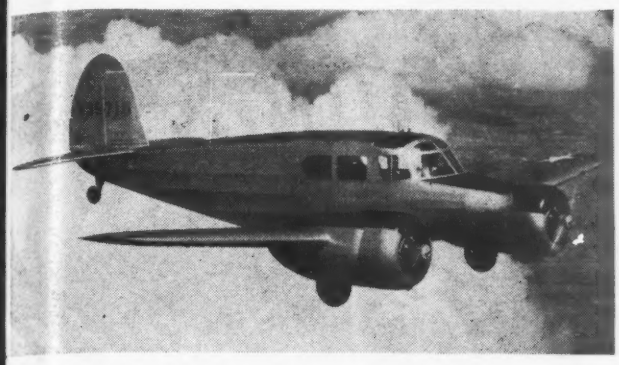
AMERICAN CHAIN & CABLE COMPANY, INC. • BRIDGEPORT, CONNECTICUT

AUTOMOTIVE AND AIRCRAFT DIVISION

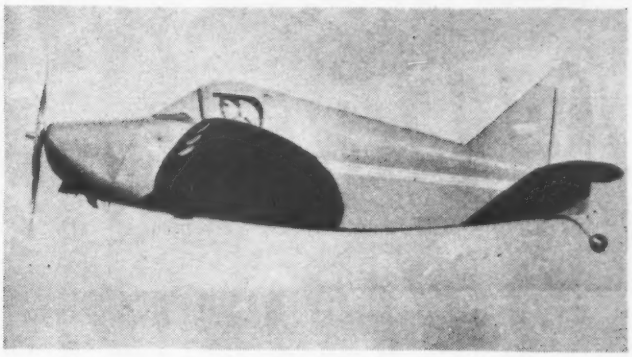
6-235 GENERAL MOTORS BUILDING DETROIT 2, MICHIGAN

For complete specifications see page 235

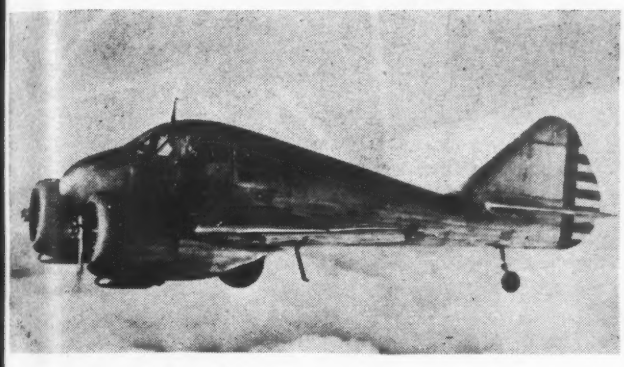
American



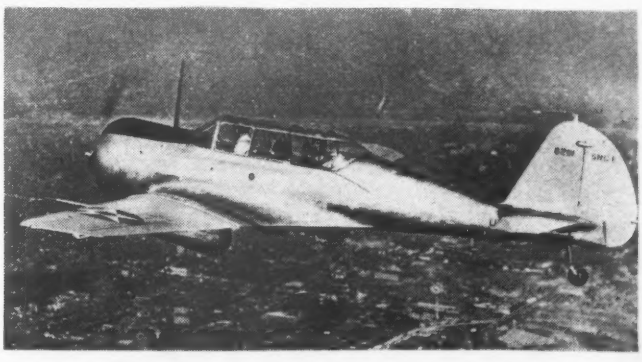
Cessna AT-17 *Bobcat*



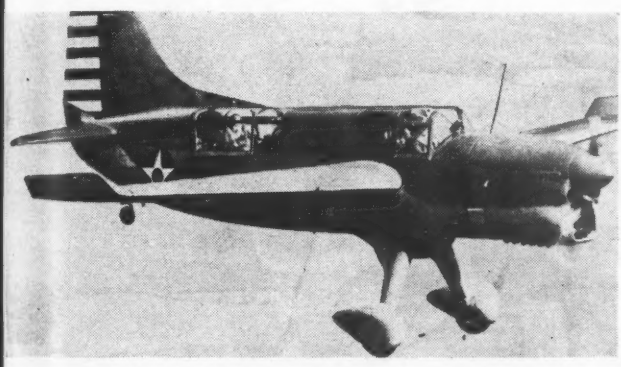
Culver Cadet



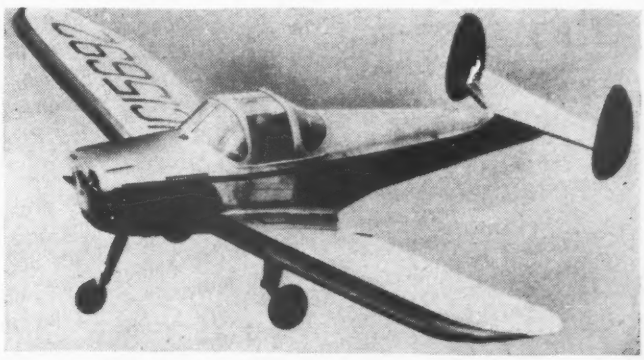
Curtiss AT-9 *Jeep*



Curtiss SNC-1 *Falcon*



Curtiss SO3C *Seagull*



Ercoupe

Fairchild PT-19

Fairchild PT-23

here's SPEED · PRODUCTION EFFICIENCY tied up with ECONOMY

Hansen

PUSH-TITE Air Hose Couplings

Today it's war and your only competition is Time. Tomorrow—Peace and with it keen competition in products, price and production in the wide open consumer market. ***Economical production*** will be tomorrow's vital factor in the manufacturing of any product and that is where Hansen **PUSH-TITE** air hose couplings come in.

¶ They're easier and faster to operate, greater production with considerable savings in time and effort. Hansen couplings are leakproof which means not only trouble-free operation but a great savings in "air" alone, in many cases sufficient to more than pay for the actual cost of couplings. ¶ If it's air, oil or grease lines it's Hansen **PUSH-TITE** Couplings because of their outstanding performance and definite savings.

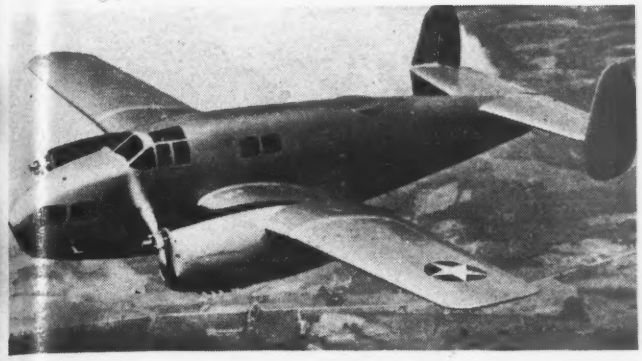
Send for Free Catalog, covering the complete Hansen industrial line.

HANSEN MFG. CO.
1786 EAST 27th STREET
CLEVELAND, OHIO

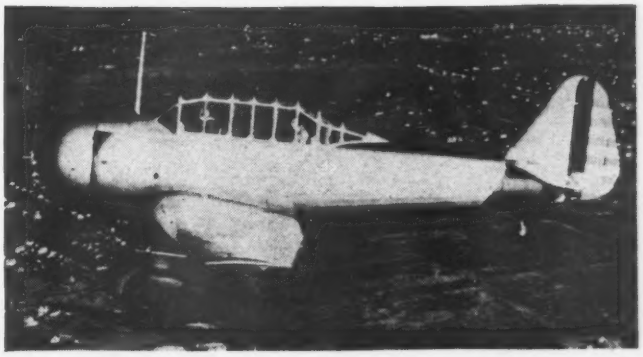
AIR HOSE COUPLINGS • HOSE CLAMP SOCKETS • HOSE CLAMPS
AIR BLOW GUNS • HOSE CLAMP PLUGS • ENGINE CLEANERS
SANDBLAST CLEANERS • AIR-LIQUID SPRAY GUNS

For complete specifications see page 235

American

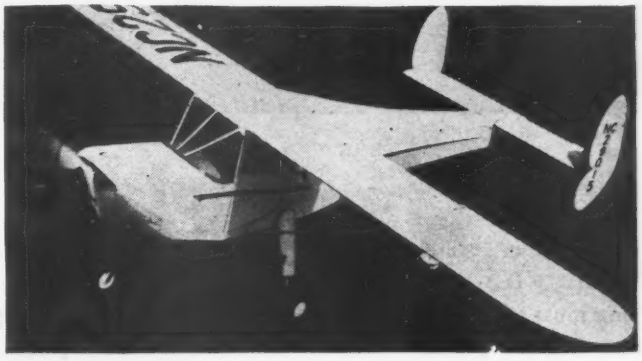


Fairchild AT-21 *Gunner*

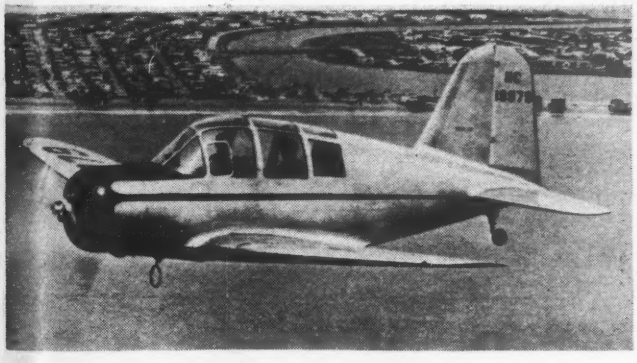


Fleetwings BT-12

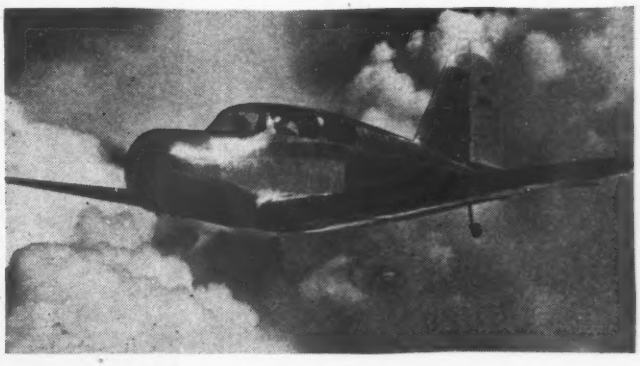
Fletcher FBT-2



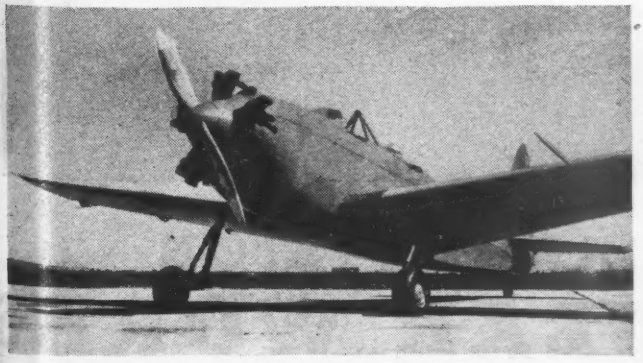
General *Skyfarer*



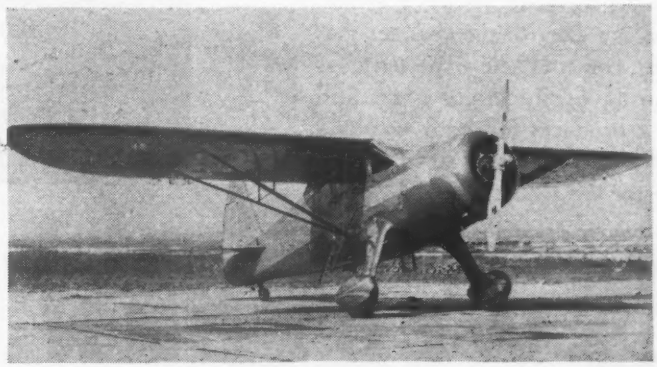
Harlow PC-5A



Harlow PJC-1



Howard DGA



Howard NH-1

but USEFUL PRECISION LATER

The big job in this war – is to win. Industry must give our soldiers the weapons with which to fight – that's the Big job now. Nothing must prevent or interfere with getting that job done.

Later, when designers' dreams start rolling off the production lines, new precision and new techniques . . . will utilize the lessons learned from the phenomenal experience of designing and producing for war.

Pacific-Western Gear Divisions, largest and best equipped plants of their kind in the West will be ready with unsurpassed facilities to manufacture anything in the line of gears and geared equipment which will be designed for peacetime living.

Perhaps you have a postwar manufacturing problem. If it involves gearing, you are cordially invited to write Pacific-Western, who are alert to the changes that must come. Their experience as leading producers of gears and gear products for both war and peace is available to all in designing for the future.

PACIFIC GEAR DIVISION

WESTERN GEAR WORKS

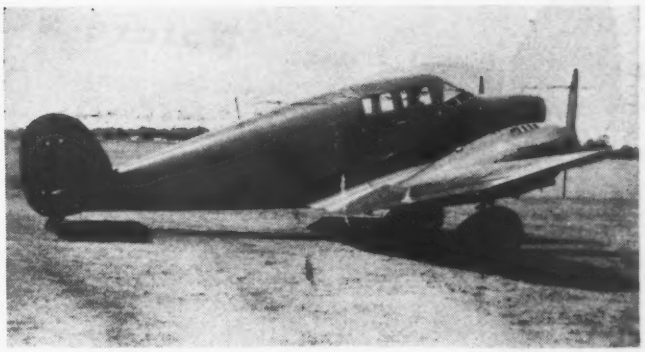
COMMERCIAL OFFICES: 11181 LONG BEACH BLVD., LYNWOOD, CALIFORNIA

PLANTS: SEATTLE, LYNWOOD, VERNON, SAN FRANCISCO

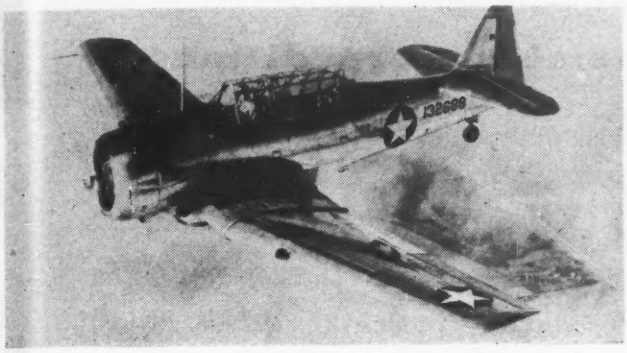
For complete specifications see page 235

American

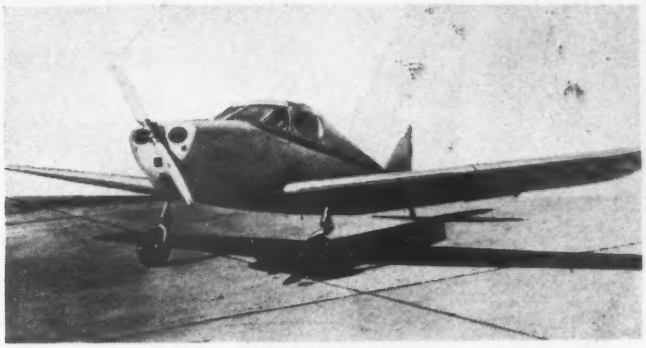
Interstate L-6



Langley 2-4-90

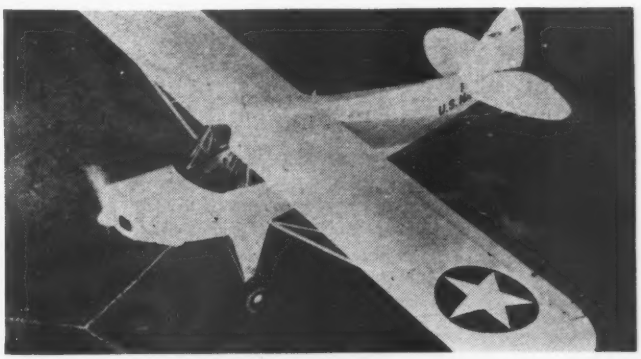


North American AT-6 *Harvard*

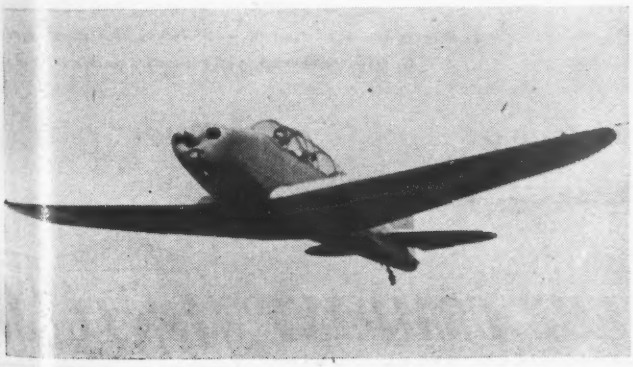


Globe Swift

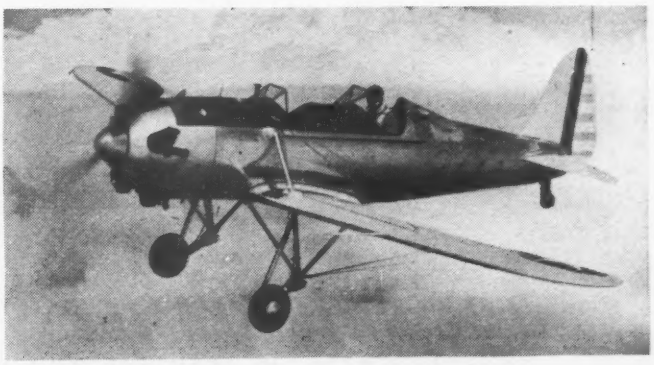
Piper L-4H



Piper HE-1



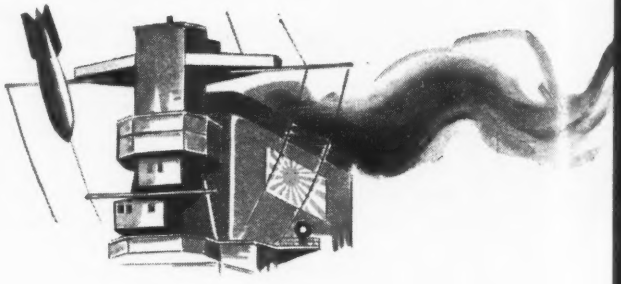
Piper PT-1



Ryan PT-22

Nature Note:

DEADLY DUCK LAYS EGGS IN CROWSNEST



The Helldiver, said to be capable of carrying a bomb load faster and farther than any other single-engine dive bomber now in service, is the latest of a long line of Curtiss dive bombers. Photo courtesy Curtiss-Wright Corp.

OSTUCO accompanies *"HELLDIVER"* on dive bombing expeditions

American plane builders are constantly giving allied airmen increasingly decisive advantages — wider range with greater speed and load capacity. Improved construction, in which strength-weight factors play an important role, is a major contribution to this dynamic superiority. To meet strength-weight requirements at such vital points as motor mounts, air frame and landing gear parts, you'll find OSTUCO seamless steel tubing in a great many planes coming off the Victory assembly line.

OSTUCO'S job today is to fill rapidly-changing seamless steel tubing specifications for rapidly-improving plane design—and at the same time to maintain its long-established record of low rejections. Tomorrow, this adaptability will be invaluable to manufacturers of planes for providing advantages of distance, safety, economy and capacity for commercial transport and travel.

... — VICTORY REMINDERS ... —

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Get in the scrap • Be on the job every day

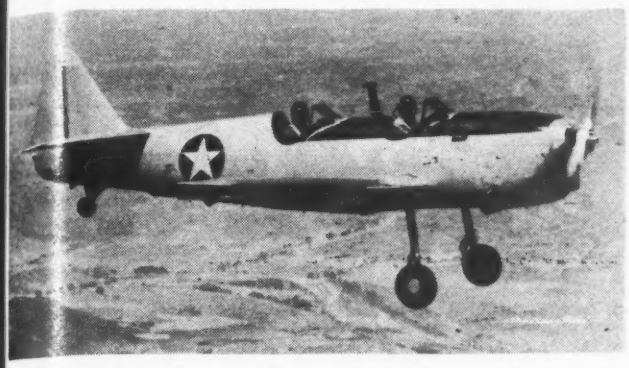
THE OHIO SEAMLESS TUBE COMPANY

MANUFACTURERS OF SEAMLESS AND ELECTRIC-WELD STEEL TUBING

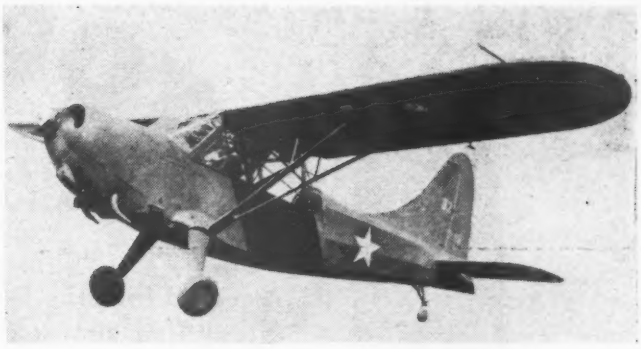
SHELBY OSTUCO OHIO

For complete specifications see page 235

American



Ryan PT-25

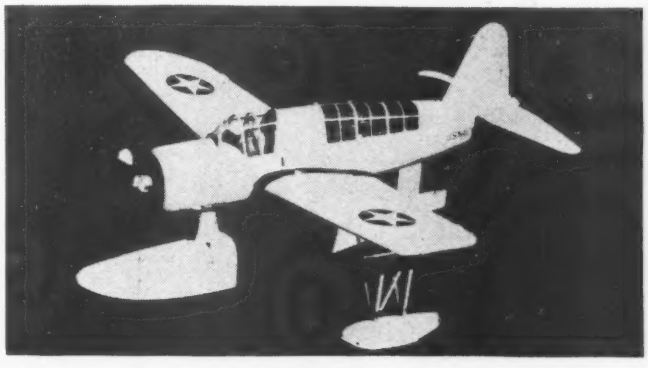


Stinson L-5 *Sentinel*

Stinson AT-19 *Reliant*

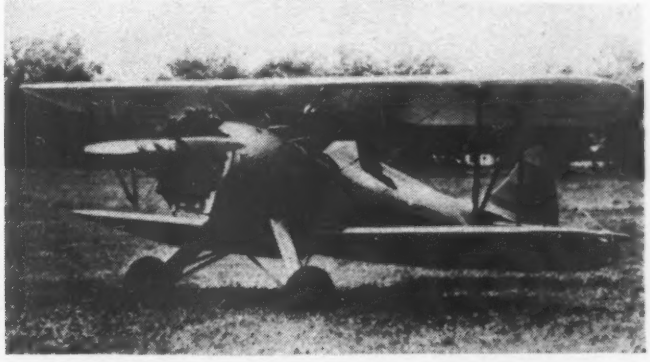
Taylorcraft L-2M

Timm N2T-1 *Tudor*



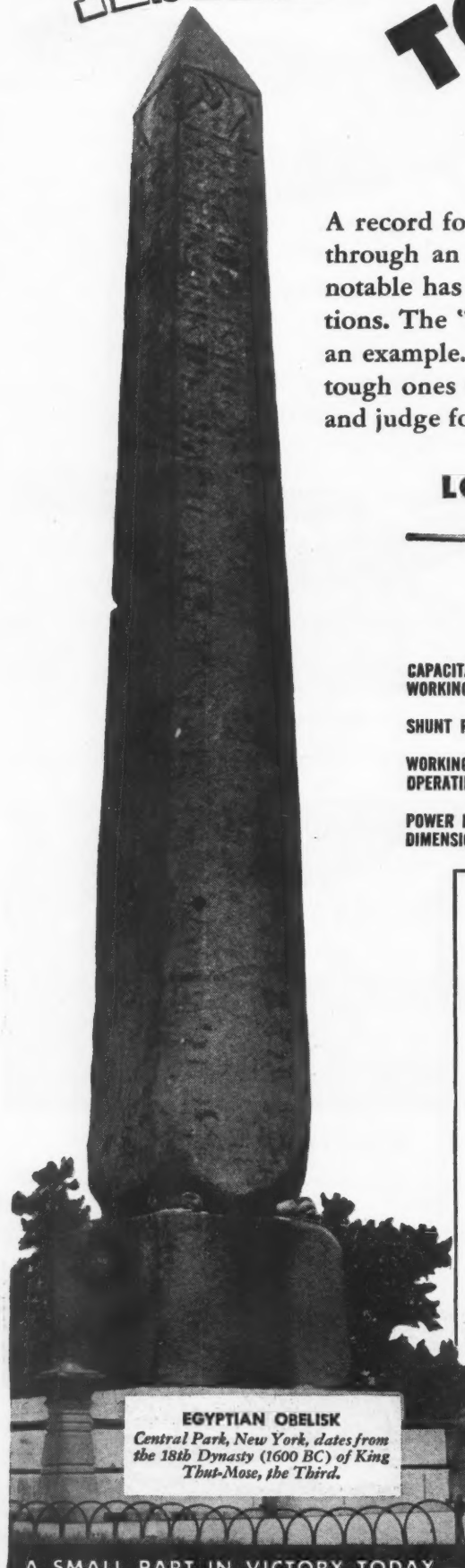
Vought OS2U-2 *Kingfisher*

Vultee BT-15 *Valiant*



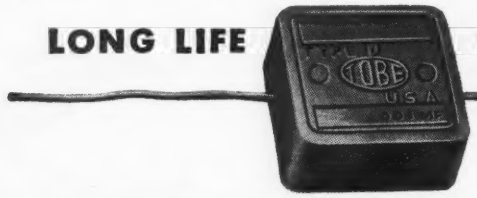
Waco UPF-7

YESTERDAY... TODAY... *Tomorrow*



EGYPTIAN OBELISK
Central Park, New York, dates from the 18th Dynasty (1600 BC) of King Thut-Mose, the Third.

A record for long life has been earned by Tobe Capacitors through an almost complete absence of "returns". Equally notable has been Tobe's ability to master difficult specifications. The "DP" Molded Paper Condenser shown below is an example. The new American War Standards "specs" are tough ones to meet—but we meet them. Ask us for samples and judge for yourself.

LONG LIFE  **ASSURED**

SPECIFICATIONS "DP" MOLDED PAPER CONDENSERS

CAPACITANCE.....001 to .04 MFD
WORKING VOLTAGE.....*See chart below*
Flash test 3 times rated DC working voltage
SHUNT RESISTANCE.....At 185° F— 1000 megohms or greater
At 72° F—50000 megohms or greater
WORKING TEMPERATURE RANGE.....Minus 50° F to plus 185° F
OPERATING FREQUENCY RANGE.....Upper limit 40 megacycles
Q at one megacycle—average 20
POWER FACTOR.....At 1000 cycles .004 to .006
DIMENSIONS.....13/16" x 13/16" x 19/64"

Capacity in MMFD.	DC Working Voltage Rating	TOBE & AMERICAN WAR STANDARDS DESIGNATIONS "A" Characteristic "B"	
1000	600—1500	CN35A102	CN35B102
1500	600—1500	CN35A152	CN35B152
2000	600—1500	CN35A202	CN35B202
2500	600—1250	CN35A252	CN35B252
3000	600—1000	CN35A302	CN35B302
4000	600—1000	CN35A402	CN35B402
5000	600— 800	CN35A502	CN35B502
6000	600— 800	CN35A602	CN35B602
7000	500— 700	CN35A702	CN35B702
8000	500— 700	CN35A802	CN35B802
10000	400— 600	CN35A103	CN35B103
20000	200— 300	CN35A203	CN35B203
30000	50— 150	CN35A303	CN35B303
40000	50— 100	CN35A403	CN35B403

A SMALL PART IN VICTORY TODAY — A BIG PART IN INDUSTRY TOMORROW

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

Official U. S. Navy Photograph

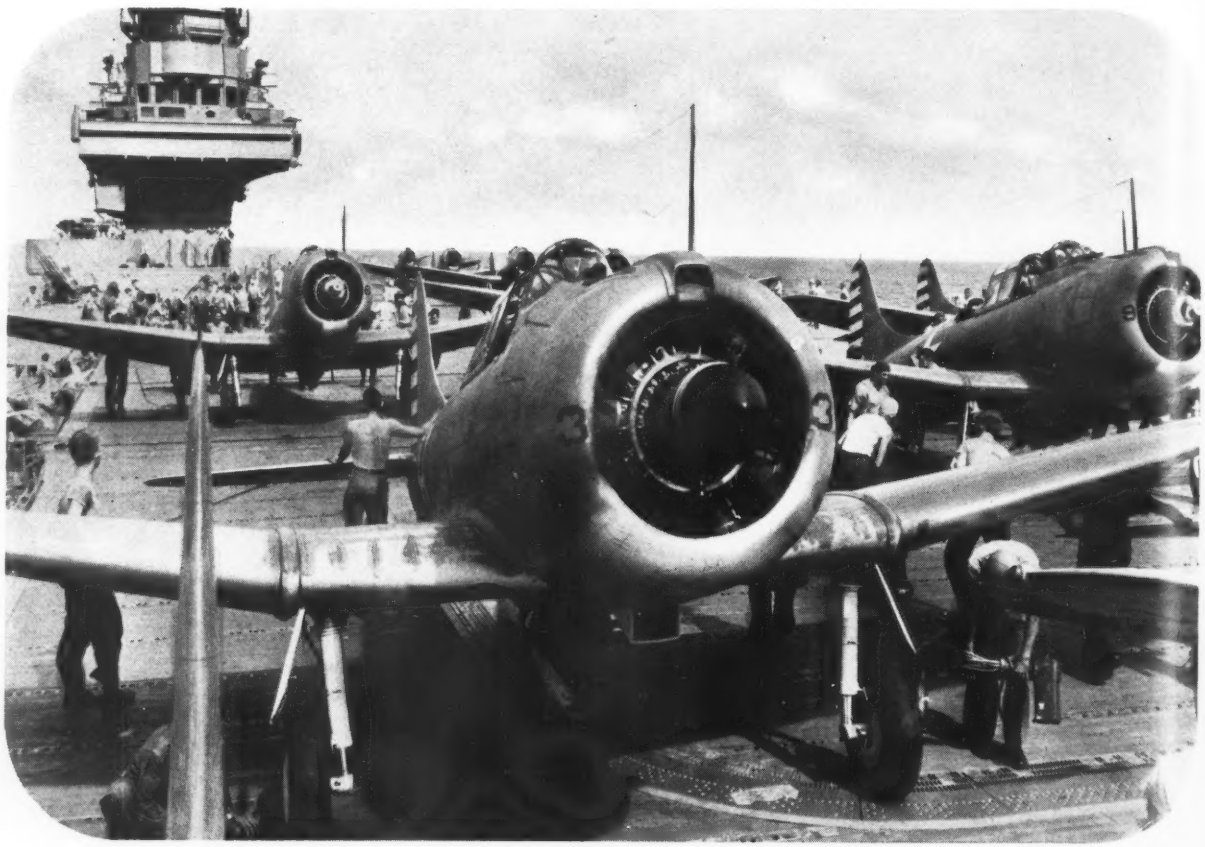
ON LIGHTER, STRONGER TIRES

UNITED STATES RUBBER COMPANY

1230 Sixth Avenue · Rockefeller Center · New York 20, N. Y.

On Carrier Deck or Desert Sand

LIGHTER AIRPLANE TIRES CARRY HEAVIER LOADS



Official U. S. Navy Photograph

When the tires on Navy fighters smack the carrier's deck, they shoulder a load far greater than tires of their size were originally engineered to take. Added weight of armor, increased load of fuel and ammunition, greater speed, range and fire-power demanded tires that could take it. That's why airplane tires had to be built lighter, stronger, tougher than ever before. On desert sands, on steel runways, or on icy landing strips, there is a U.S. Royal Airplane Tire especially designed and engineered to do every job.

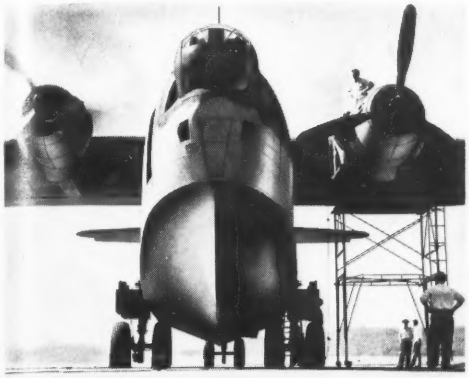
1230 SIXTH AVENUE **UNITED STATES**

For Flight Deck Landings

THE U. S. ROYAL

High Pressure Channel Tread

Tail wheel tires on carrier-based planes like the Vought Corsair have to take the shock of flight deck landings and at the same time hold the plane under control with minimum bounce. U. S. Channel Treads keep rebound at a minimum, withstand the high temperatures of fast stops, and track straight without dangerous skidding. The broad, flat tread gives better flotation on soft or sandy soil, too.



For Beaching Flying Boats

THE U. S. ROYAL

Beaching Gear Tire

Tires for beaching gear must be able to shoulder the great weight of these giant boats. Since these loads are sustained at low speeds with few sudden shocks and strains, U. S. Beaching Gear Tires are engineered to handle loads far in excess of those carried by conventional tires. For easy installation, the U. S. Royal Beaching Gear Tire is equipped with a special water valve so that the tire may be partially inflated with water.

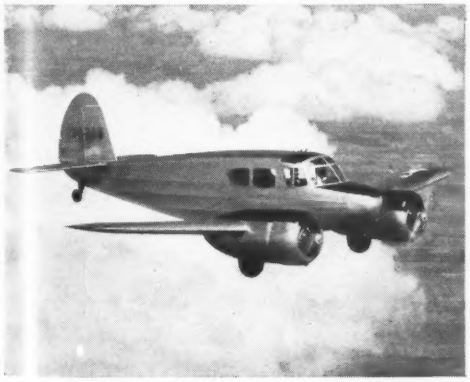
For Tri-cycle Landing Gear

THE U. S. ROYAL

Low Profile

Nose Wheel Tire

The U. S. Royal Nose Wheel Tire is engineered for the special operating conditions of tri-cycle landing gear. The tire has an unusual cross-sectional shape, extra wide at the rim with less than normal distance between the rim and the tread contact area when inflated. Should the nose wheel be damaged or fail on landing, the drop is reduced to a minimum.



For High Brake-Heat

THE U. S. ROYAL

Fabric Base Tube

Excessive use of brakes often causes overheating. Tubes of standard construction may not stand up under these conditions. "U. S." Field Airplane Tire Engineers developed the U. S. Royal Fabric Base Tube that can take high brake drum heat for as much as 450 to 500 hours when tubes of conventional construction often fail in less than five hours.

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They Look Alike
But One Tire Has 64% More Strength

These three U. S. Royal Airplane Tires look alike. And yet what a difference there is—an all important difference that means thousands of pounds of extra fighting power.

The Army and the Navy needed tires that could carry the greater loads of today's long range air warfare, tires of vastly greater strength and reduced weight. Overall size could not be increased. Drawing on their experience in pioneering the rayon cord tire, "U.S." Airplane Tire Engineers developed a new tire built with nylon cords. Weight was reduced 16% from cotton cords and strength increased 64%. Today, these giant Nylons are serving on Army and Navy planes under the toughest landing and take-off conditions, pointing the way to the stronger, lighter, better airplane tires for the future.

Listen to the New York Philharmonic Symphony broadcast over Columbia network every Sunday afternoon 3:00 to 4:30 P. M. Eastern War Time.

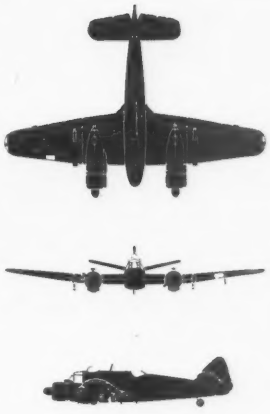
UNITED STATES RUBBER COMPANY

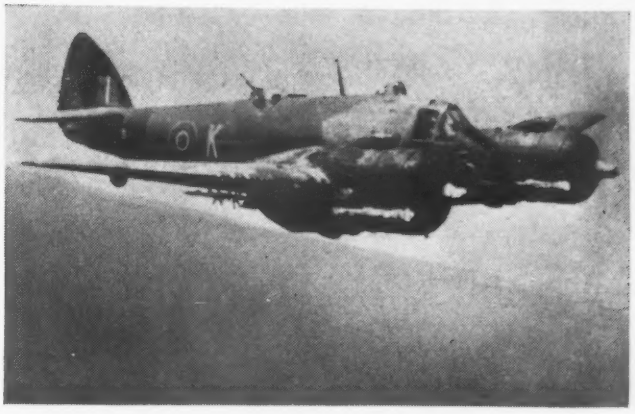
1230 SIXTH AVENUE · ROCKEFELLER CENTER · NEW YORK 20, N. Y.

Bristol *Beaufighter III*

Three-place all-metal long-range fighter used extensively in Mediterranean campaign, also as intruder plane operating against Nazi-held territory from English bases. Recently, torpedo-carrying version has been widely used to attack German shipping in North Sea. As fighter craft it mounts four 20-mm. cannon in nose and six 303-cal. machine guns in wings. Service ceiling is 33,000 ft.

Span.....57 ft. 10 in.
Length.....41 ft. 4 in.
Height.....15 ft. 10 in.
High speed.....352 mph.
Max. range.....1,300 mi.
Gross wt.....21,000 lb.
Power....two 1,600 hp. Bristols.

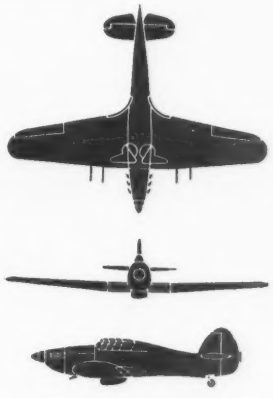




Hawker *Hurricane IID*

Single-place medium-altitude fighter originally armed with twelve 303-cal. Browning machine guns, but as II C is equipped with four 20-mm. cannon or as II D with two 40-mm. cannon for low-level attack work, such as "tank busting." As low-level bomber (II B) it carries one 500-lb. or two 250-lb. bombs mounted externally under wings.

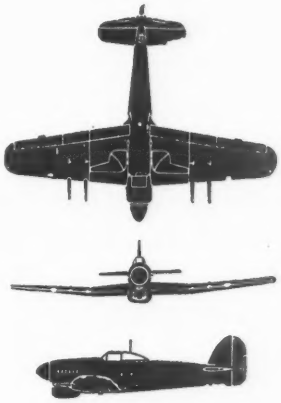
Span.....40 ft.
Length.....31 ft.
Height.....13 ft. 1 in.
High speed.....335 mph.
Cruising speed.....213 mph.
Range.....730 mi.
Gross wt.....6,600 lb.
Power..one 1,030-hp. Rolls Royce *Merlin XX*.

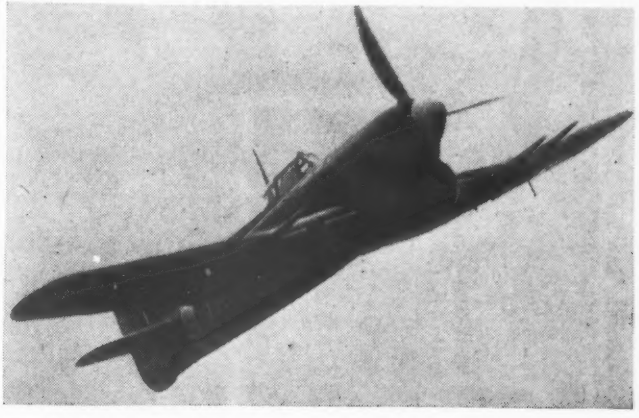


Hawker *Typhoon*

Single-place, all-metal monocoque fuselage craft now used almost exclusively for low-level attack and bombing against ground Nazi installations in France. Unusually large cowling enclosing oil and engine coolant radiators gives plane appearance of having radial engine. It has, however, a 24-cyl. H-shaped Napier *Sabre* with twin crankshafts geared together driving four-blade propeller.

Span.....41 ft. 7 in.
Length.....31 ft. 11 in.
Height.....15 ft. 3½ in.
High speed.....400 mph.
Power..one 24-cyl. H-section 2,000 hp. Napier *Sabre*.

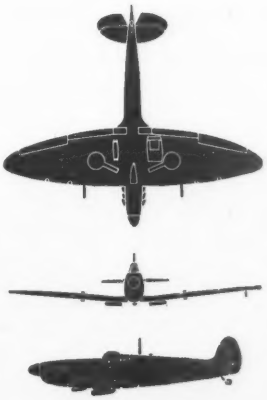




Supermarine *Spitfire IX*

Powered by two-stage supercharged Rolls Royce *Merlin* 61 engine to give added performance at high altitudes, it is rated as Britain's No. 1 fighter, succeeding *Spitfire V* which has recently appeared in clipped wing version to improve performance at low altitudes. Armament of *IX* is usually two 20-mm. cannon and four .303-cal. machine guns, all mounted in wing outside propeller arc.

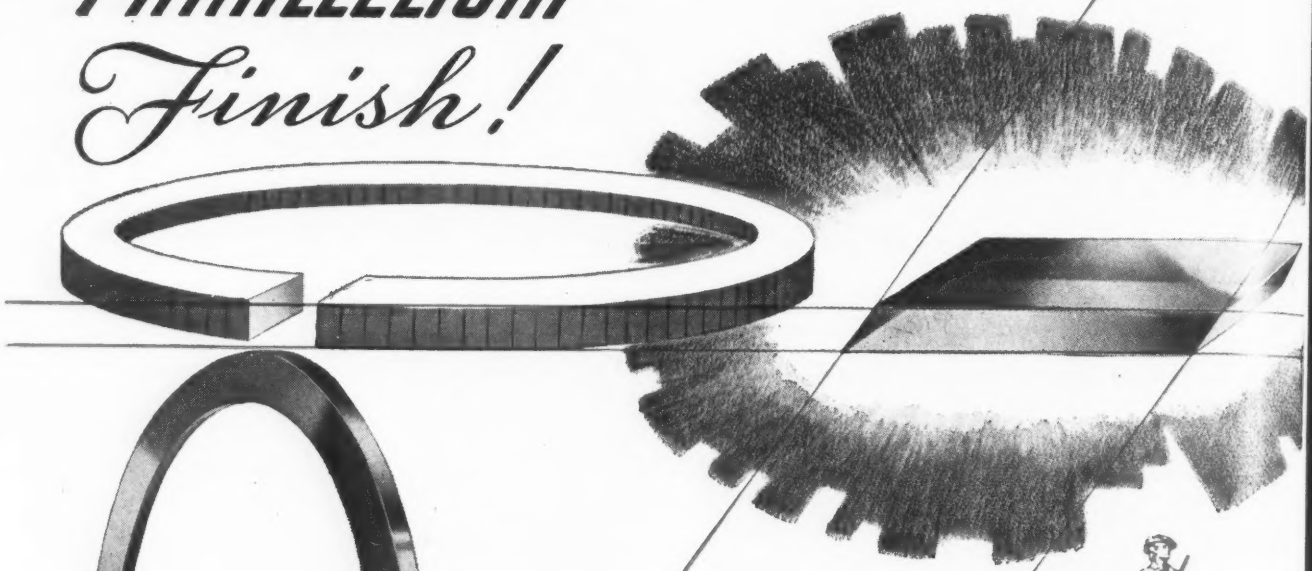
Span.....36 ft. 10 in.
Length.....31 ft. ½ in.
Height.....11 ft. 5 in.
High speed.....over 400 mph.
Gross wt.....5,850 lb.
Power.one Rolls Royce *Merlin* 61.



FLATNESS

PARALLELISM

Finish!



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FOR VICTORY

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It is our hope that you will write us about our products, manufacturing facilities and engineering experience. Address your inquiry to General Offices, Ramsey Accessories Mfg. Corp., 3706 Forest Park Blvd., St. Louis 8, Mo. Factories in St. Louis, Fruitport and Windsor, Ont., Canada.

RAMCO MICRO LAP

AIRCRAFT PISTON RINGS

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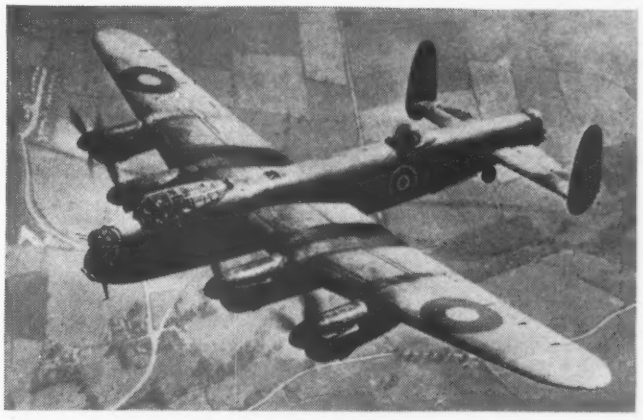
Bombers

Avro *Lancaster*

Considered England's No. 1 heavy bomber, *Lancaster* was designed for night mass attacks on German objectives, and it is being produced in Canada as well as Britain. Most efficient of British "heavies," its bomb load is roughly comparable to that of present American craft in the heavy class. Armament consists of twelve .303-cal. machine guns in nose, mid-upper, mid-lower, and tail turrets.

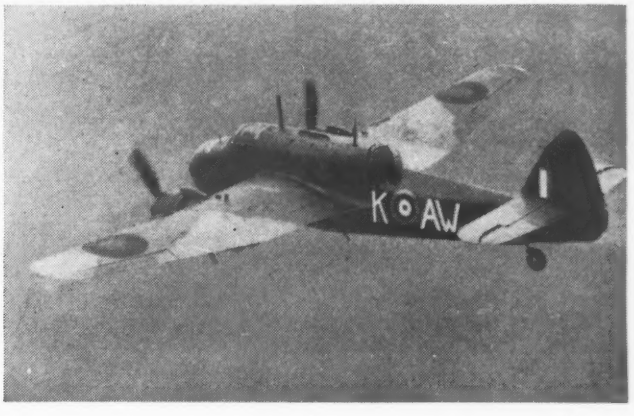
Span.....102 ft.
Length.....69 ft. 4 in.
Height.....20 ft.
High speed (approx.)....300 mph.
Max. range.....3,000 mi.
Gross wt.....63,000 lb.
Power.....four 1,600-hp. Bristols.



Bristol *Beaufort*

Four-place reconnaissance bomber which has become a standby torpedo carrier for the RAF, seeing widespread service in the Mediterranean theater as well as over the English Channel and North Sea. Also utilized as a mine layer. Bomb load ranges from 1,000 to 2,000 lb., depending on the mission. Armament consists of seven .303-cal. machine guns, including two in dorsal power turret.

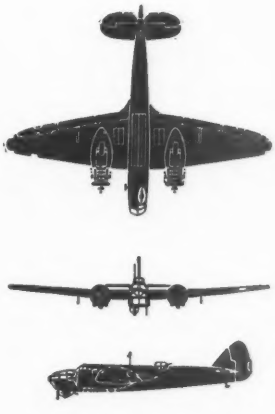
Span.....58 ft. 6 in.
Length.....44 ft. 7 in.
Height.....14 ft. 3 in.
High speed.....275 mph.
Power..two 1,145-hp. Bristol *Taurus.*

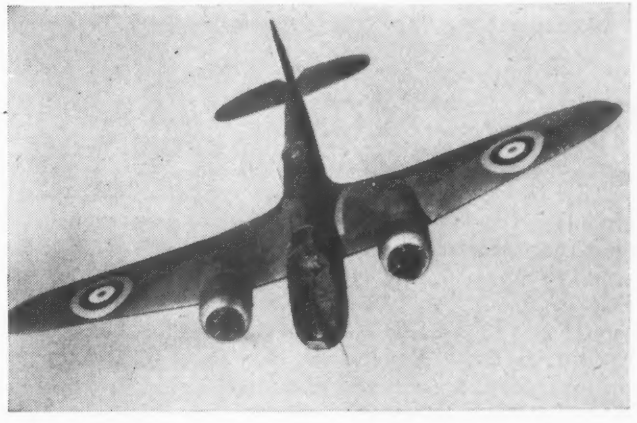


Bristol *Blenheim IVF*

Three-place long-range fighter-bomber widely used, like the *Beaufort,* for low-level attacks against enemy shipping. Fighter version armament includes four .303-cal. machine guns firing forward from blister beneath fuselage and dorsal power turret containing one gun of similar caliber. Some special modifications used in Africa were known as *Bisleys,* officially the *Blenheim V's.*

Span.....56 ft. 4 in.
Length.....42 ft. 9 in.
Height.....9 ft. 10 in.
High speed.....295 mph.
Max. range.....1,900 mi.
Gross wt.....14,400 lb.
Power..two 920-hp. Bristol *Mercury XV's.*

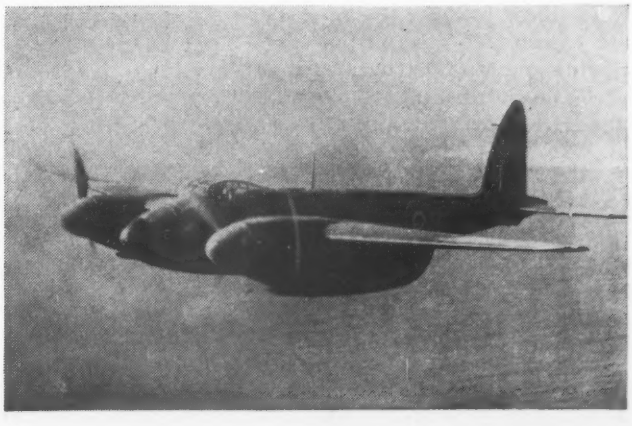


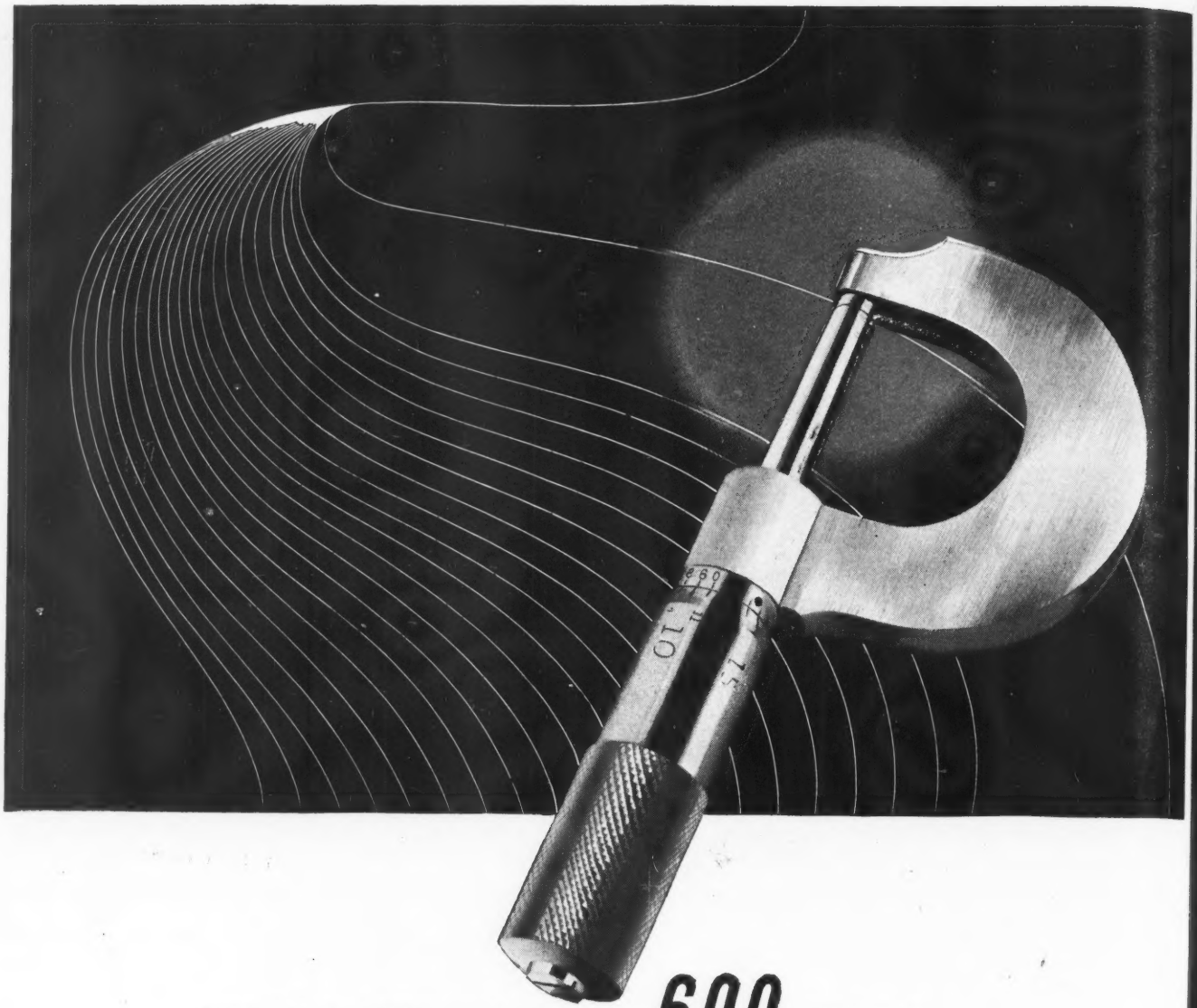


deHavilland *Mosquito*

Two-place wooden bomber, fighter, or photo-reconnaissance craft of exceptional speed. Fuselage and wings are all plywood, and interesting construction employs layer of balsa between plywood layers. Developed from *Comet* racer which won England-Australia race in 1934. Fighter version shown in photo is armed with four 20-mm. cannon and four .303-cal. machine guns. Bomber version can carry up to 2,000 lb. over limited range.

Span.....54 ft. 2 in.
Length.....40 ft. 9½ in.
Height.....17 ft. 3 in.
High speed.....over 400 mph.
Max. range.....about 2,000 mi.
Power..two 1,280-hp. Rolls Royce *Merlin XXI's.*





SPLIT A HUMAN HAIR 600 TIMES

That is five millionths of one inch. An infinitesimal dimension . . . a dimension that's part and parcel of every working day at Schrillo . . . a language that is spoken fluently by our craftsmen. For it's not unusual in this plant to work to .000005" tolerances in the manufacture of Schrillo Precision Products. The industries we serve require it —Schrillo scientific laboratory control assures it.

Schrillo Pipe Plugs and Ring Gauges are examples of the meticulous care taken in the manufacture of our products. The unsurpassed accuracy of these gauges is reflected in the increased speed of today's production line operations. For gauges serve not only to determine accuracy of dimensions—they prove the identity of production assembly duplications, assuring perfect interchangeability of parts.

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SCHRILLO

LOS ANGELES CALIFORNIA

Handley Page *Halifax II, Ia*

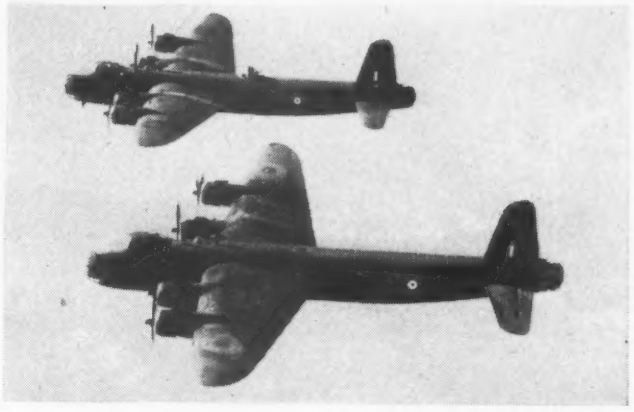
Basically the original "Halibag" design—one of the earliest of the British four-engine bombers—this latest modification incorporates squared fins whose greater area gives increased stability, also new streamlined nose greatly resembling that of the Boeing B-17F and G. Armament includes single hand-operated machine gun in the nose, two in power dorsal, and four in power tail turret.

Span.....98 ft. 10 in.
Length.....70 ft. 1 in.
Height.....22 ft.
High speed (approx.)....300 mph.
Max. range.....3,000 mi.
Power..four 1,175-hp. Rolls Royce *Merlin 22's.*

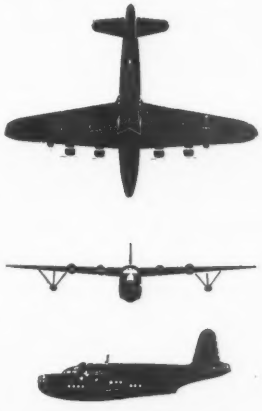
Short *Stirling*

Little changed by modifications since it first went into service, this seven- to ten-place heavy bomber is used extensively in night mass bombing attacks on German production centers. Single tail, set just ahead of power gun turret, tends to give the *Stirling* an appearance of unusual length. Armament consists of eight .303-cal. Browning machine guns in nose and dorsal and tail power turrets.

Span.....99 ft. 1 in.
Length.....87 ft. 3 in.
Height.....22 ft. 9 in.
High speed (approx.)....300 mph.
Range.....2,000 mi.
Gross wt.....70,000 lb.
Power.....four 1,600-hp. Bristol *Hercules XI*

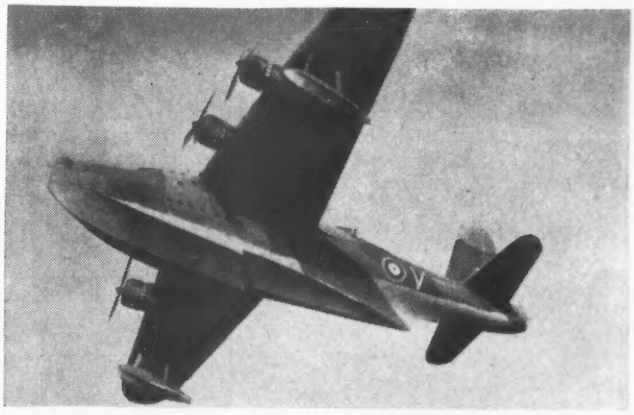


Short *Sunderland*



Coastal reconnaissance bomber used on long-range missions, including anti-submarine patrol. Several were recently converted to civil freight and passenger carrying by British Overseas Airways for the England-West African route. Conversions included installation of 1,000 hp. Bristol *Pegasus* 18 engine and added fuel tanks to increase range.

Span.....112 ft. 9½ in.
Length.....87 ft. 4 in.
Height.....32 ft. 11¾ in.
High speed.....210 mph.
Range.....2,880 mi.
Gross wt.....45,700 lb.
Power..four 850-hp. Bristol *Pegasus.*



Fairey *Albacore*

In service with the Coastal Command since 1940, the *Albacore*—successor to the *Swordfish*—is the only operational biplane serving the RAF. Wings fold back against fuselage to permit carrier-based operations. Has been used for a wide range of jobs running from freight lugging through torpedo bombing to recently unpublicized parties against Nazi E-boats in company with *Typhoons.*

Span.....50 ft.
Length.....39 ft. 10 in.
Height.....14 ft. 2 in.
High speed.....190 mph.
Range.....700 mi.
Power..one 1,065-hp. Bristol *Taurus II.*

SKILL AND SPIRIT THAT DESERVE TOP *Performance...*

And top performance is what every builder of motor operated equipment is striving to provide for the men of our air force who are doing such a superb job today. • In producing fractional horsepower motors for aircraft equipment, our thirty years' experience in the special application field has been invaluable in solving the many problems which have arisen. This experience, in the form of *thorough engineering,* therefore is an integral part of every Black & Decker motor. • Whether motors are for combat equipment today, or peaceful pursuits tomorrow, *thorough engineering* is a prerequisite to top performance.

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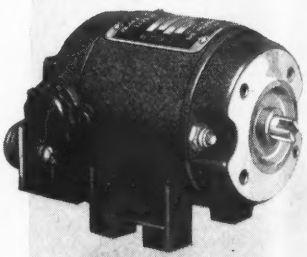

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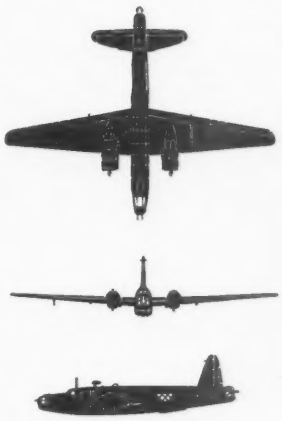
Vickers *Wellington III*

Unusual geodetic construction employed in both fuselage and wings is said to have given this five-place medium bomber ability to absorb heavy punishment. Widely used in both Mediterranean theater and over Nazi-held territory within range of English bases. Also used as torpedo bomber and mine locater. Armament consists of six machine guns, two each in powered nose and tail turrets, and two in sides.

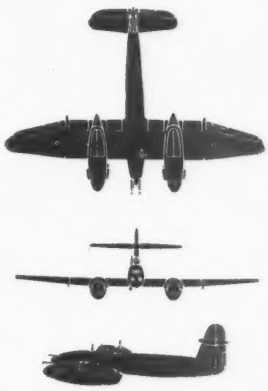
Span.....86 ft. 2 in.
Length.....61 ft. 3 in.
Height.....17 ft. 5 in.
High speed.....263 mph.
Max. range.....1,550 mi.
Gross wt.....24,850 lb.
Power.....two 1,370-hp. Bristol *Hercules XI.*

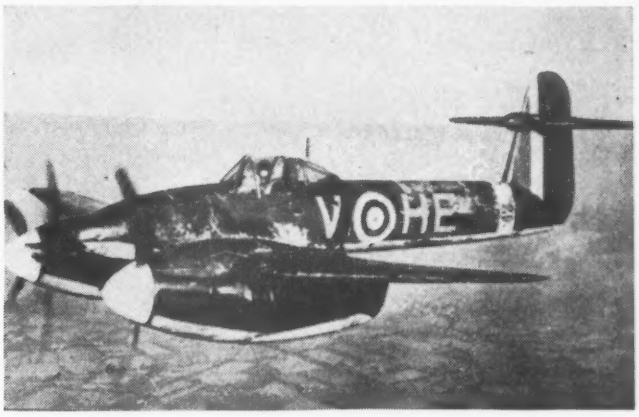


Westland *Whirlwind*

Britain's only twin-engine single-place fighter, the *Whirlwind* has been used mostly for intruder attacks—strafing enemy craft just leaving or returning to their bases—and for low-level attacks on railroad trains or light shipping. Unusual design feature is high stabilizer, located near top of fin. Armament consists of battery of four cannon grouped in the nose.

Span.....45 ft.
Length.....32 ft. 3 in.
Height.....14 ft. 6 in.
High speed (approx.)...400 mph.
Gross wt.....5,920 lb.
Power..two 850-hp. Rolls Royce *Peregrines.*



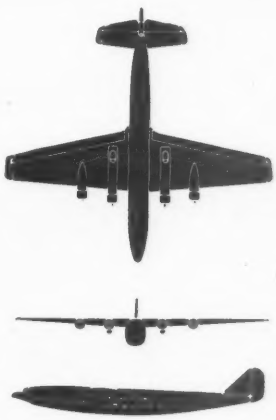


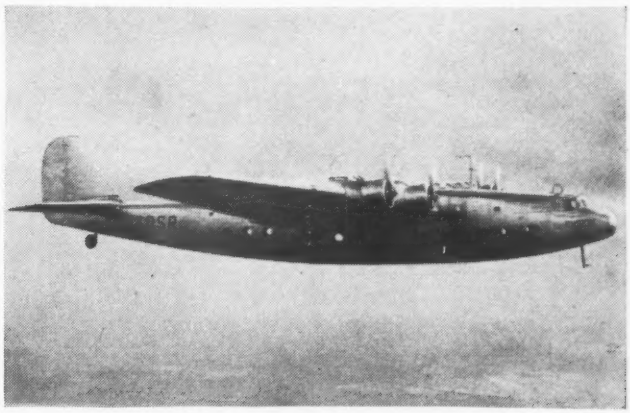
Cargo-Transport

Armstrong Whitworth *Ensign*

One of Britain's leading prewar commercial transports "gone to war" moving high priority men and materiel. In peacetime role it carried from 20 passengers (with sleeping accommodations), to 40 on shorter day runs. Normal crew consists of two pilots and radio operator.

Span.....123 ft.
Length.....114 ft.
Height.....23 ft.
High speed.....210 mph.
Normal range.....1,370 mi.
Gross wt.....52,500 lb.
Power.....four 900-hp. Wright *Cyclones.*

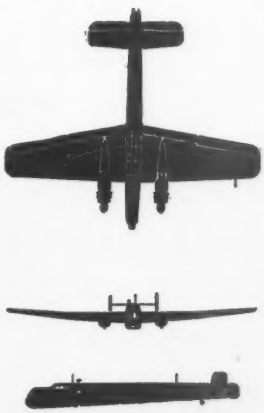


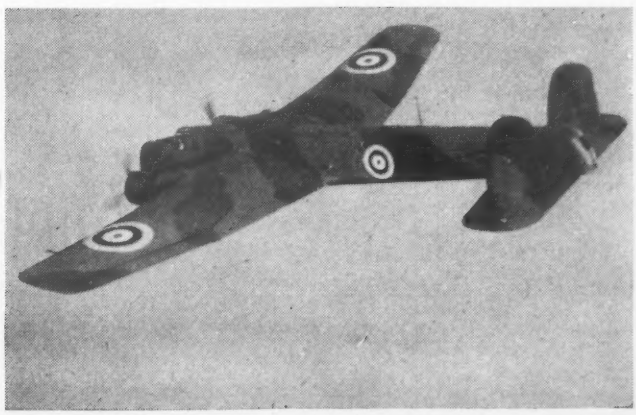


Armstrong *Whiteley V*

Retired from bomber service by newer craft, several of the RAF's *Whitleys* have been converted into cargo carriers for long-haul work. Only difference in the transport's appearance is fairing to replace bombardier's compartment and tail gun turret. Extra fuel tanks carried in bomb bays give added range without curtailing cargo space.

Span.....84 ft.
Length.....72 ft. 6 in.
Height.....15 ft.
High speed.....225 mph.
Range (approx.).....2,200 mi.
Gross wt.....27,900 lb.
Power..two 1,145-hp. Rolls Royce *Merlin X.*





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it would burst into flame!

HURTLING through space at 7 miles a second, meteors actually "rub" the atmosphere so hard they burst into flame. Though modern war planes attain nothing like this unearthly speed, nevertheless they must be specially equipped to meet the terrific air impact, the contraction and expansion, vibration and other very real "gremlins" infesting the highways overhead.

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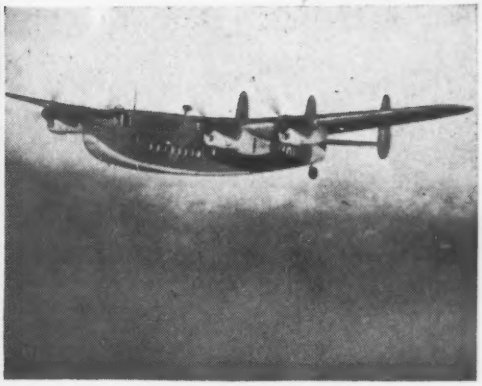
Avro *York*

Rather than a conversion of the *Lancaster* bomber, the *York* is, in reality, a re-designed airplane. While it utilizes the same wing, power plants, and landing gear, the fuselage is 9 ft. 2 in. longer and incorporates triple vertical stabilizers. Maximum capacity is 50 passengers. *Yorks* currently are being used on North Atlantic route between England and Canada.

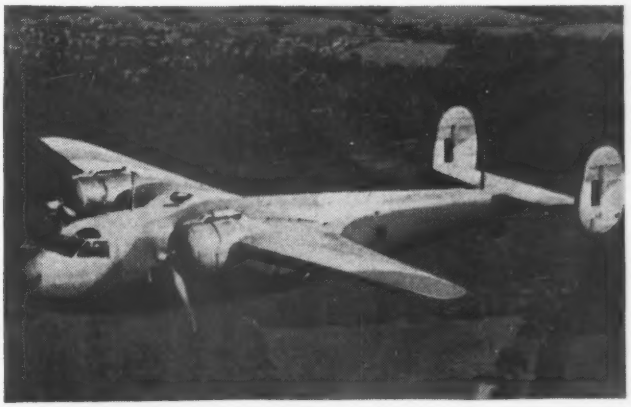
Span.....102 ft.
Length.....78 ft. 6 in.
Height.....20 ft.
High speed (approx.)...300 mph.
Power..four 1,260-hp. Rolls Royce *Merlin XX's.*



deHavilland *Flamingo*

Another peacetime commercial transport now in war paint serving as medium-range transport and communication craft. In contrast with all-wood *Mosquito*, this de-Havilland product is all-metal and bears some resemblance to American-built Douglas DC-5, several of which were in service with Dutch.

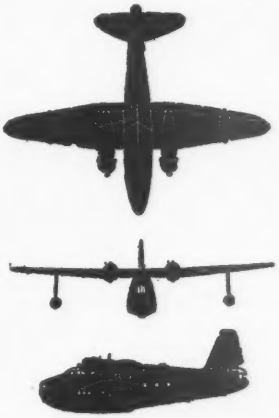
Span.....70 ft.
Length.....51 ft. 10 in.
Height.....15 ft. 3 in.
High speed.....239 mph.
Normal range.....1,210 mi.
Gross wt.....17,600 lb.
Power..two 930-hp. Bristol *Perseus XVI's.*

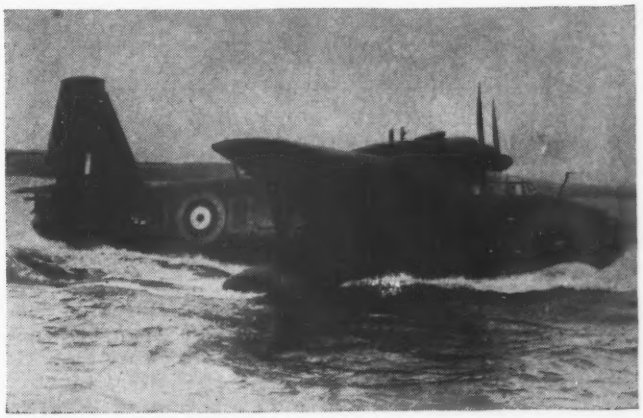


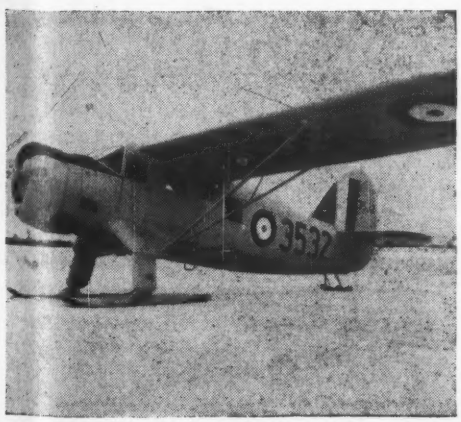
Saunders Roe *Lerwick*

Originally developed as a general purpose coastal reconnaissance bomber, the *Lerwick* has lately been largely engaged in transport operations. As a combat craft it mounted three power-operated gun turrets—one in the nose, one atop the fuselage 'midships, and one aft of the fin and rudder—and carried a crew of six.

Span.....81 ft.
Length.....63 ft.
Height.....20 ft.
Power.....two 1,375-hp. Bristol *Hercules II's.*







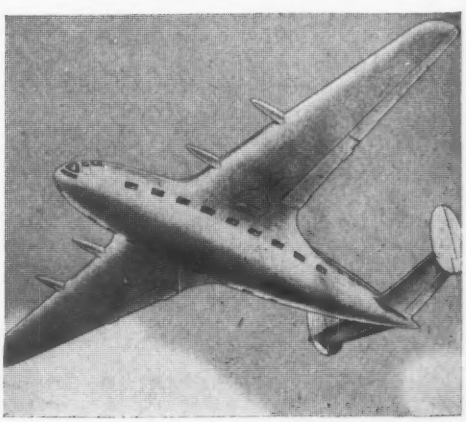
Noorduyn *Norseman*

A Canadian-designed craft built in Canada. Also used by U. S. Army as UC-64.

Span.....51 ft. 6 in.
Length..... 32 ft.
Height.....10 ft. 3 in.
High speed.....170 mph.
Max. range.....1,200 mi.
Gross wt.....7,450 lb.
Power.....one 550-hp. P & W.

Phillips & Powis Proposed Transport

Span.....150 ft.
Length.....110 ft.
Wing area.....2,350 sq. ft.
High speed (est.).....425 mph.
Gross wt.....130,000 lb.



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Lord produces, in standard sizes, an infinite variety of bonded rubber shear type mountings for vibration control, ranging from mountings for radial engines to those used for very delicate, light-weight instruments. In addition, Lord produces thousands of special parts designed for particular conditions which cannot be satisfied by standard parts. While designed functionally to isolate vibration, Lord products have the additional characteristics of being compact, light in weight, and easy to install.

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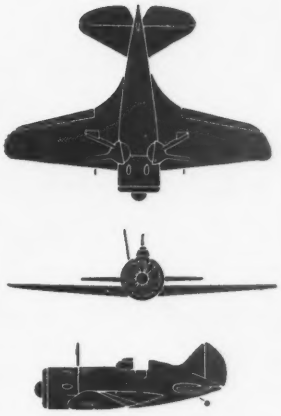
IT TAKES RUBBER IN SHEAR TO ABSORB VIBRATION

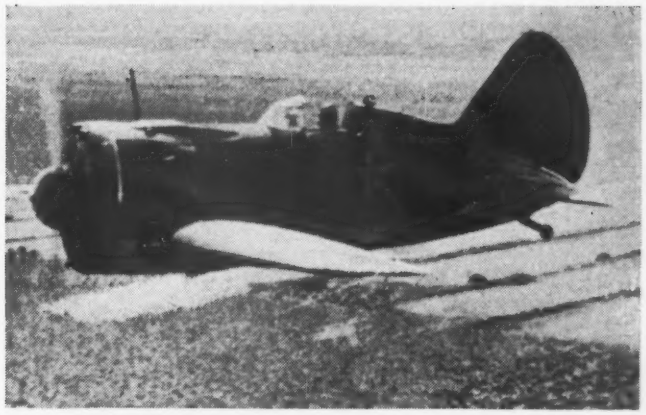
Fighters

I-16

Although it was used as far back as the Spanish Civil War, where it was thoroughly battle-tested against Nazi planes of the day, this craft is still used extensively by the Russians despite the fact that newer types have vastly superior performance. While no details are available, armament is said to consist of two 20-mm. cannon and four .50-cal. Maxim machine guns.

Span .....29 ft. 2 in.
Length .....20 ft. 4 in.
High speed .....280 mph.
Cruising speed .....225 mph.
Normal range .....465 mi.
Gross wt. .....3,190 lb.
Power.....one 1,000 hp. M-63.



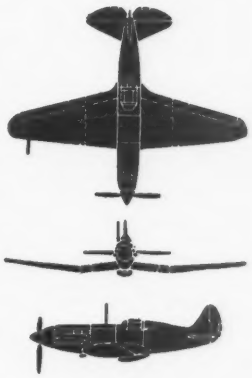


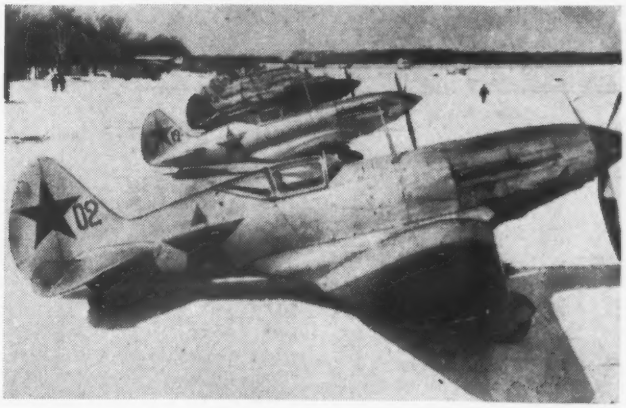
All Russian photos by Sovfoto

MIG-3

Sometimes referred to as the I-18, this single-seat fighter is one of the Red Air Force's first line combat craft. While originally designed as an interceptor it has, in keeping with recently developed tactics, also been used as a combination fighter-bomber for attacks against motorized troops. Armament consists of two 20-mm. cannon mounted in the wings, two .50-cal. and two .30-cal. machine guns firing through the propeller.

Span.....37 ft. 6 in.
Length.....31 ft. 2 in.
High speed .....380 mph.
Normal range .....500 mi.
Gross wt. .....6,200 lb.
Power...one 1,250-hp. liquid-cooled AM-35A.

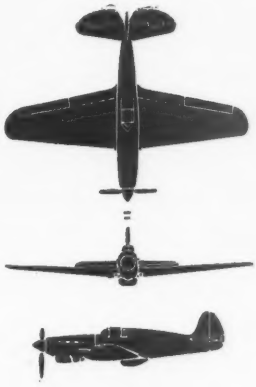


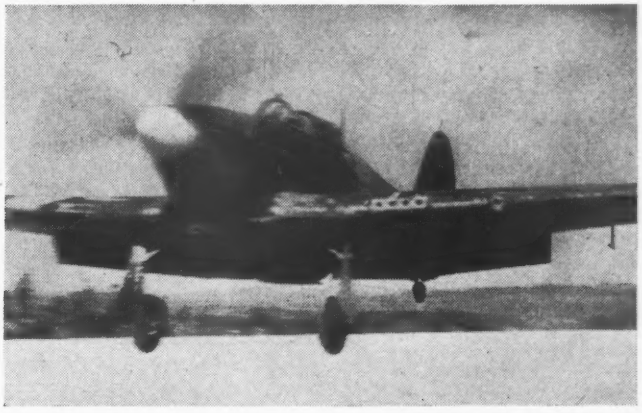


YAK-1

One of the fastest Russian fighters, this craft, sometimes referred to as the I-26, has often been called the "Russian *Spitfire*." It, too, has been doubling as a low-level attack bomber, but no information is available as to size of the bomb load. Fighter armament consists of two 20-mm. cannon mounted in the wings, also four Maxim machine guns.

Span .....38 ft.
Length .....32 ft.
Height .....10 ft.
High speed (approx.)....400 mph.
Gross wt. (approx.).....6,000 lb.
Power.....one 1,300-hp. Toupolev M-38.





IL-2 *Stormovik*

Probably the most widely known plane in the Red Air Force—because of the stellar role it played as an Army cooperation craft in low-level attacks against mechanized Nazi columns. Bomb loads vary from four 250-lb. rocket bombs, through ten 100-lb.-ers to one 1,000 lb. bomb. Armament consists of two 32-mm. wing-mounted cannon and four .50-cal. machine guns.

Span .....49 ft. 2 in.
Length .....38 ft. 6 in.
Height .....10 ft. 9 in.
High speed .....280 mph.
Power.....one 1,300-hp. Toupolev

ECONOMY

ALTHOUGH Camloc High Speed Fasteners are responsible for tremendous savings over worn or lost bolts and nuts, Camloc's greatest economy lies in its time savings. A quarter turn of the screw driver effects or releases a secure fastening. Installation too is a major feature of Camloc's time economy. Now exclusively for fighting aircraft, production will one day turn to the many industries which are fast coming to accept this as the modern fastening. Write for illustrated catalog.

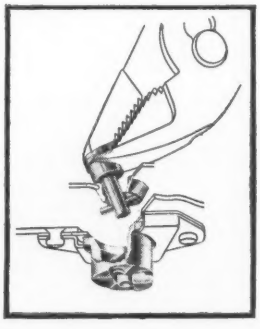


Illustration shows floating Cam Collar which is freely self-centering, thus allowing for misalignment up to 1/8" *in any direction.* Stud Assembly is easily inserted or removed as a unit. Selection of correct size at final assembly allows for cumulated tolerances. Cross pin is permanent. Stud grips Cam Collar uniformly preventing sheet warpage. A complete line of Cam Collars is available for single hole or rivet type mounting.

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Russian

Yak-7

Bearing a great resemblance to YAK-1, this craft is undoubtedly of same basic design. With no structural differences discernible, it is believed the new number indicates changes only in armament or power.

I-53 Chica

A development of the once-famed I-15 *Chato* fighter used extensively in the Spanish Civil War. This new version has retractable landing gear, gull wing, and cabane struts.

Yak-9

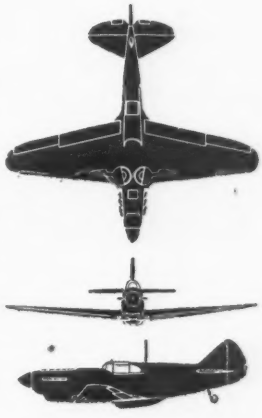
Another of the Yak series with the familiar inline liquid cooled engine, long slender fuselage, retractable landing gear and air intake beneath the fuselage. Shorter greenhouse set above, rather than faired into, fuselage distinguishes it from others of the series.

Span.....36 ft.
Length.....30 ft.
High speed.....345 mph.
Gross wt.....approx. 6,000 lb.
Power.....one 1,100-hp. M-105.

Lagg-3

All-wood fighter-bomber of typical Russian design, using inline, liquid cooled engine. Wings have wood spars and ribs, plywood-covered and monocoque fuselage is wood covered.

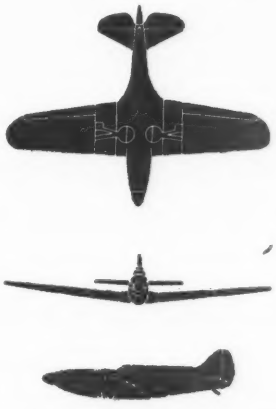
Span.....31 ft. 9½ in.
Length.....29 ft. 5 in.
Height.....8 ft. 4 in.
High speed.....348 mph.
Cruising speed.....279 mph.
Landing speed.....87 mph.
Normal range.....400 mi.
Gross wt.....7,040 lb.
Wt. empty.....5,770 lb.
Service ceiling.....30,000 ft.
Wing area.....188 sq. ft.
Wing loading.....37.2 lb. sq. ft.
Power loading.....6.37 lb. sq. ft.
Power.....one 1,100-hp. M-105.



I-17

A development of the mid-thirties, this single place fighter has only fair performance, but indicated the Russian trend toward heavy armament with four machine guns mounted in the wings and rack beneath the fuselage for a 200-250 lb. bomb.

Span.....33 ft. 1 in.
Length.....24 ft. 2 in.
High speed.....310 mph.
Cruising speed.....273 mph.
Gross wt.....4,230 lb.
Service ceiling.....36,000 ft.
Normal range.....600 mi.
Power.....one 1,100-hp. M-100.



La-5

One of the very few Red Air Force fighters using a radial, aircooled engine. Little information is available but, aside from the engine, it bears a great resemblance to the Lagg-3—shown just above—with landing gear, wing plan, greenhouse and empennage appearing to be identical.

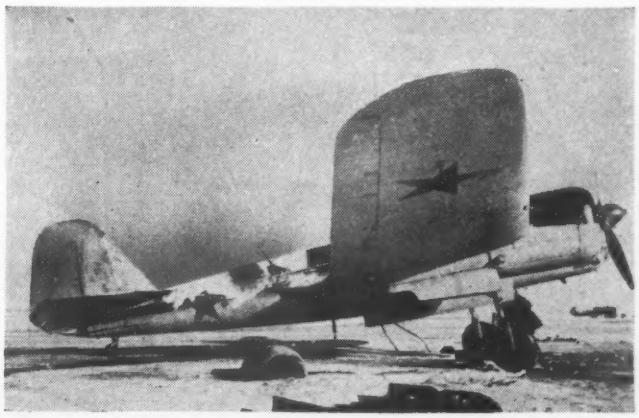
Span.....31 ft. 9½ in.
Length.....28 ft. 7 in.
High speed.....370 mph.
Gross wt.....7,400 lb.
Power.....one 1,600-hp. radial aircooled.

Bombers

DB-3

A direct development of the twin-engine bomber which flew over the North Pole from Moscow to New Brunswick back in 1939, the Ilyushin-designed DB-3 was one of the most effective medium bombers used against the Nazi Wehrmacht. Normal crew is three to four men, and armament consists of machine guns in the nose and a single hand-operated machine gun aft in the fuselage.

Span.....70 ft. 2 in.
Length.....46 ft. 10 in.
High speed.....265 mph.
Cruising speed.....186 mph.
Max. range.....2,500 mi.
Gross wt.....25,000
Power.....two 1,100-hp. M-88's.



NEW POWER

for FAIRCHILD 24's and MEYERS OTW's

The Kinner R-56 . . . because of its reputation for absolute dependability . . . has been selected to power an increasing number of Fairchild 24's and Meyers Trainers for the hour-upon-hour, day-after-day training of WTS students.

The 160 hp Kinner has been in daily use in hundreds of Army Trainers for years . . . and is thoroughly proven for the grueling assignment of pilot training.

If you want added power and performance in your Fairchild 24's and Meyers OTW's, investigate the Kinner R-56. Change-overs can be made in the field. The necessary alterations in cowls, engine mounts and auxiliary equipment are supplied . . . ready for installation. Write Kinner for details.

Another First for Kinner . . .

Kinner was America's first engine manufacturer to install a battery of hydraulic dynamometers for production testing of engines . . . to accurately measure and insure uniformly high performance.

Kinner

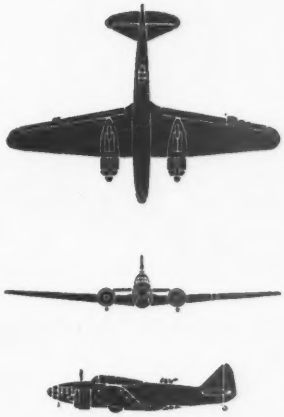
KINNER MOTORS, INC. GLENDALE, CALIF.

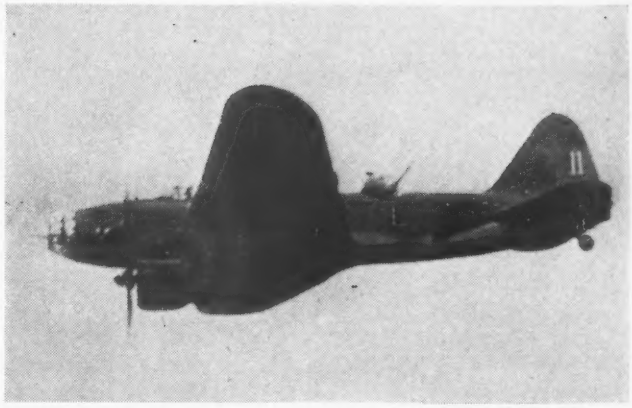
1919—BUILDERS OF DEPENDABLE AIRCRAFT ENGINES FOR A QUARTER CENTURY—1944

DB-3F

Representing a direct development of the DB-3, the principal difference in appearance is in a more streamlined nose and installation of a power gun turret in place of the hand-operated fuselage gun. Engine cowlings have been re-designed, with the result that performance is better than that of the DB-3. Both models have retractable gun turret in the fuselage belly near the empennage.

Span.....70 ft. 2 in.
Length.....46 ft. 10 in.
High speed.....Over 265 mph.
Cruising speed.....Over 186 mph.
Max. range.....2,500 mi.
Gross wt. (Approx.)....25,000 lb.
Power...two 1,100-hp. M-88's.

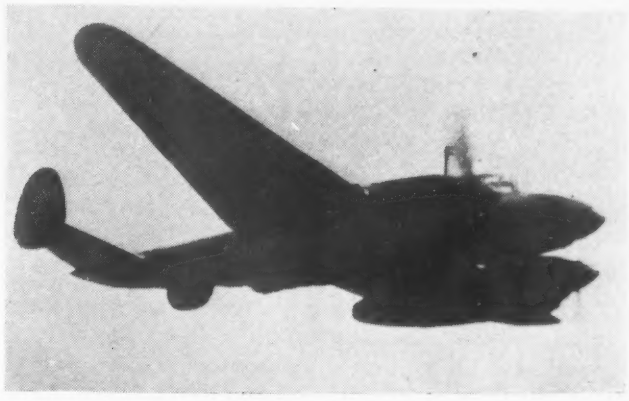




PE-2

This three-man light bomber greatly resembles the newer YAK-4 and, at a distance, might also be mistaken for the German Messerschmitt ME-110. An Ilyuchin design, the PE-2 has been widely used for low-level attack work. Bombardier is prone in the nose beneath the pilot and the rear gunner is housed in the pilot's canopy, thus putting all crew members ahead of the wing. Bomb load runs up to 2,000 lb.

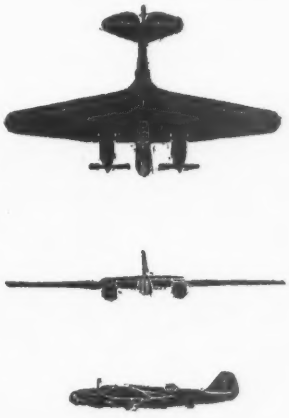
Span .....60 ft.
Length .....45 ft. 6 in.
Height .....13 ft.
High speed.....310 mph.
Power.....two 1,300-hp. M-105's.

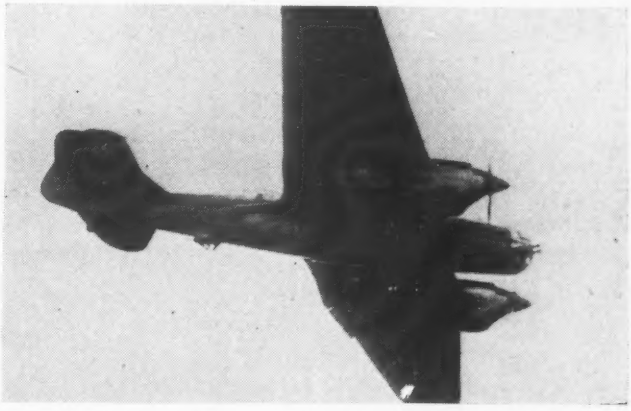


SB-3

An old standby of the Red Air Force, this three-man medium bomber is a direct development of the SB-2, which was battle-tested in the Spanish Civil War. Installation of "venetian blind"-type dive brakes gives versatility to the craft. Heavily armed, it carries two machine guns in an unorthodox nose turret and additional firepower in dorsal and ventral fuselage turrets.

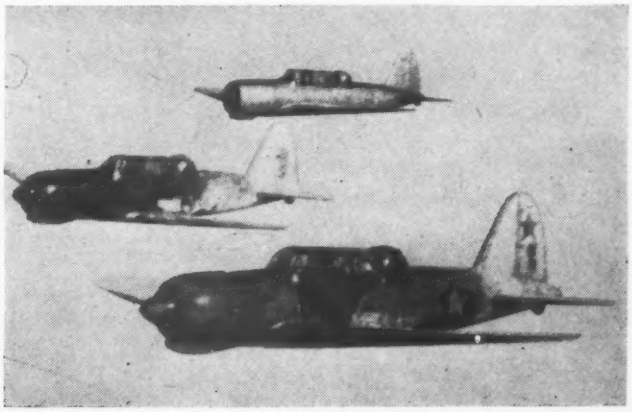
Span .....66 ft.
Length .....41 ft. 6 in.
High speed.....280 mph.
Cruising speed.....220 mph.
Normal range .....Over 550 mi.
Power.....two 950-hp. Hispano-Suiza type M-12's.





SU-2

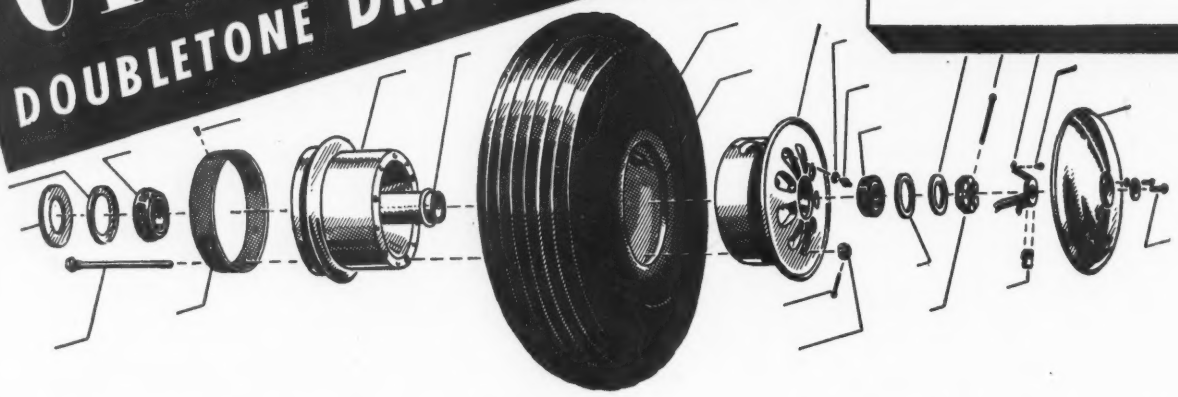
Although it greatly resembles the Brewster *Bermuda*, this Ilyuchin-designed two-place bomber is in no sense a copy. Unverified reports emanating from Germany state that the craft has also appeared as a single-place fighter armed with four heavy caliber machine guns firing forward. Armament of the bomber version is not known. Power plant is an 1,100-hp. M-88.



CRAFTINT

DOUBLETONE DRAWING PAPER

Examples of drawings made on Doubletone can be seen in the "Sketch Book of Design Detail"—this section of Aviation Magazine. Note their clarity, accuracy and fine detail.



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★ For shaded tracings and blueprints, Van Dykes or black and white prints by direct contact. Solves all shading problems and eliminates cross hatching.

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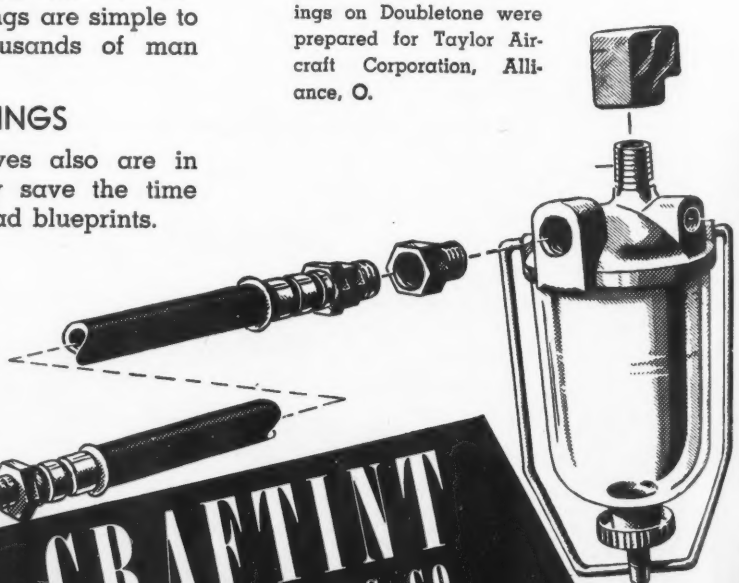
These Handbook Drawings on Doubletone were prepared for Taylor Aircraft Corporation, Alliance, O.



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Keeping BOOST ON THE BUTTON!

The Simmonds-Hobson Automatic Engine Control

TAKE-OFF calls for split-second coordination of airplane, propeller, and engine controls. Climb at rated power...flight at cruising...all mean continuous adjustments of mixture, RPM, and manifold pressure which complicate a pilot's job.

Acting as a third hand for the pilot, the Simmonds-Hobson Automatic Engine Control simplifies the pilot's task, and provides additional engine protection. Units now in production are designed to take over throttle and mixture during all conditions of operation. The Simmonds-Hobson Automatic Engine Control keeps "boost" on the button, and prevents mixtures which might spell disaster for the engine.

More advanced designs now under way extend automatic control to the propeller governor, spark, and other engine functions.

Simmonds Equipment Flies With Every Type of Allied Aircraft

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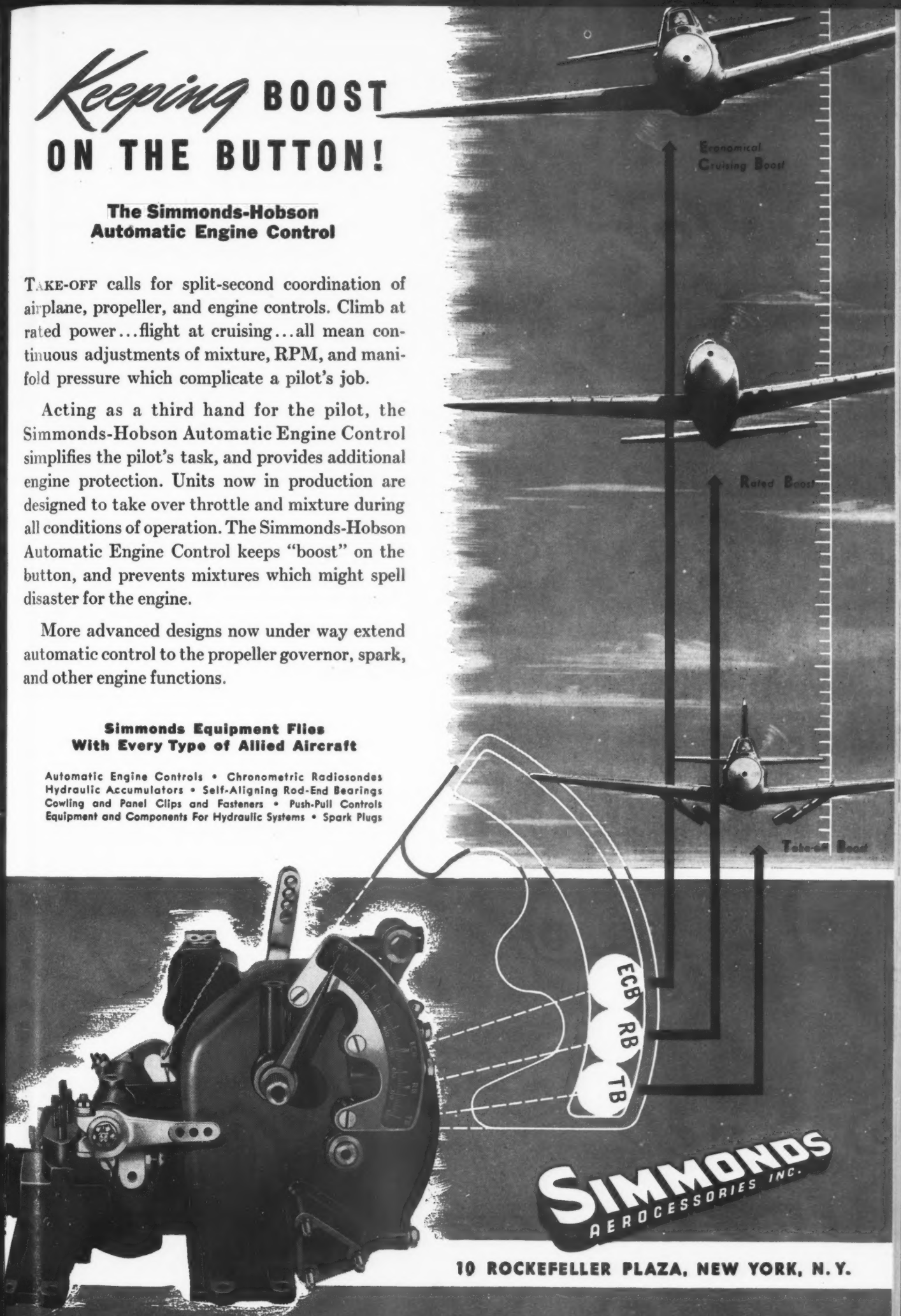


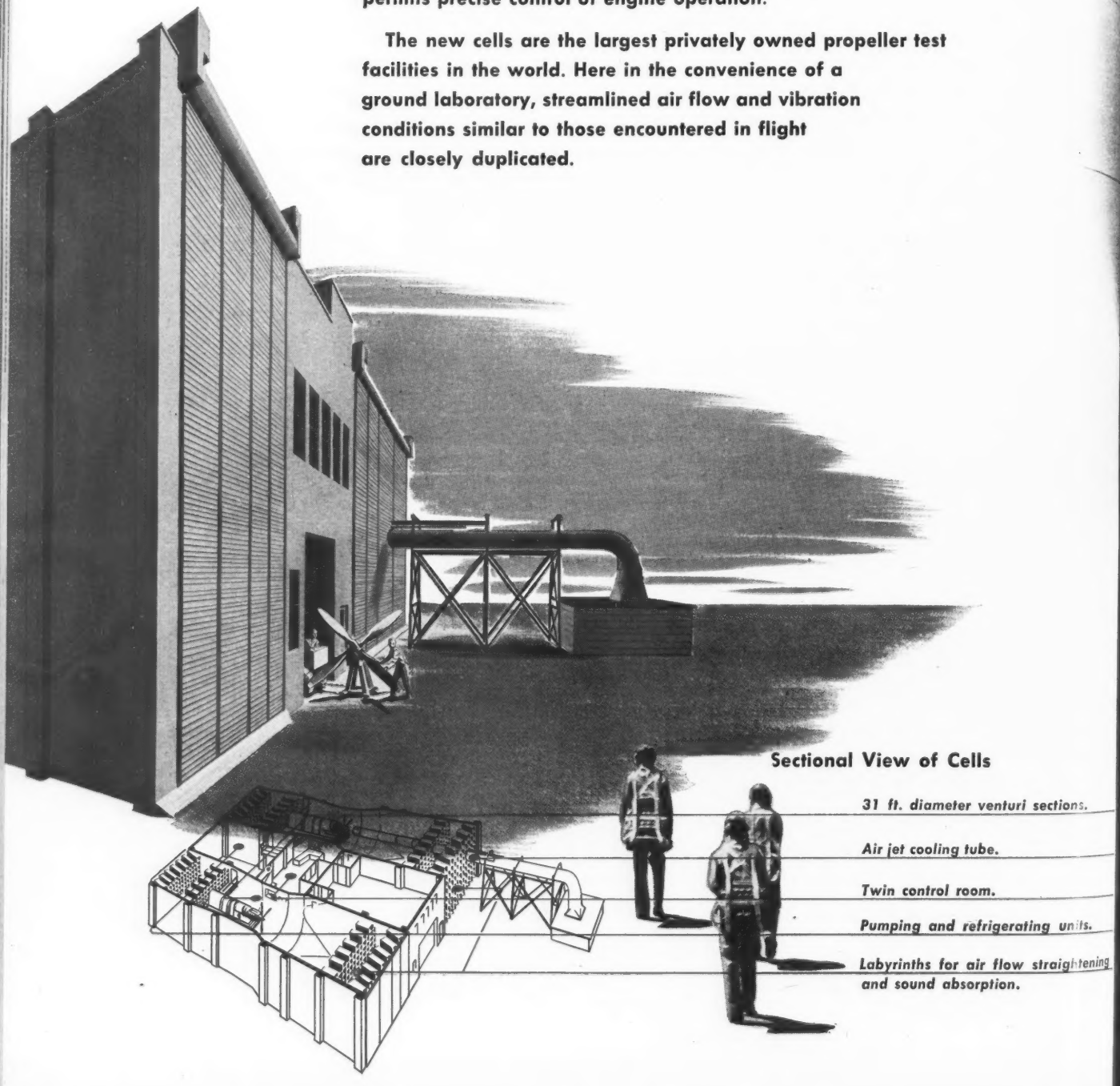
SIMMONDS AEROCESSORIES INC.

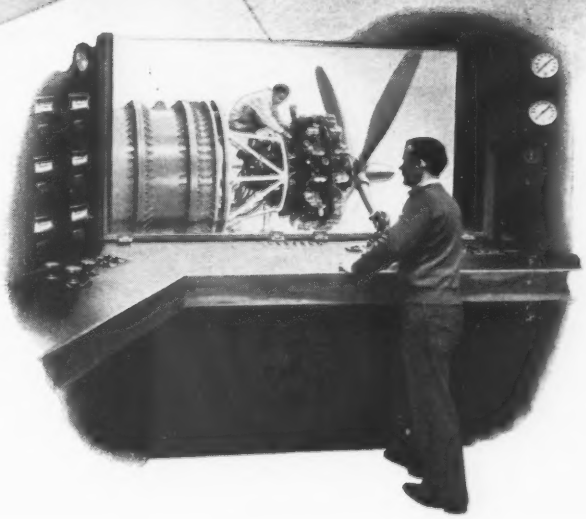
10 ROCKEFELLER PLAZA, NEW YORK, N. Y.

proving ground for the big blades

Stepping far ahead of current engine and aircraft design, the new Curtiss twin test cells have been built for the express purpose of developing the huge blades of the future. Propellers up to 30 ft. in diameter may be tested on either liquid or air-cooled engines with ratings up to 5000 HP. A scientifically designed venturi section eliminates turbulence of air. A combination of cooling systems permits precise control of engine operation.

The new cells are the largest privately owned propeller test facilities in the world. Here in the convenience of a ground laboratory, streamlined air flow and vibration conditions similar to those encountered in flight are closely duplicated.


Sectional View of Cells
31 ft. diameter venturi sections.
Air jet cooling tube.
Twin control room.
Pumping and refrigerating units.
Labyrinths for air flow straightening and sound absorption.



In operation, the 48-inch air jet cooling tube slides forward until it covers the spinner and is within a few inches of the propeller blades. A central cone inside the tube spreads the air into annular ring form to deliver it around the hub and directly into the cowl opening. The operator in the sound-proof control room has a clear view of the propeller and engine during the test from several observation windows.

CURTISS ELECTRIC PROPELLERS

Curtiss-Wright Corporation, Propeller Division

Excerpt from a letter written by a former Breeze worker, now in our armed forces.

While our ship was on the ground, I spied a Breeze ignition shield and told the mech, 'I used to build 'em' He grinned and said, 'Best damn shield there is,' and with that my chest expanded to twice normal. A compliment like that from a motor doc reflects the swell job you folks are doing back home there on the production line. Keep it Up!

-what's in a *Name*

It All Depends on Past Associations and Present Circumstances

There's plenty in a name—when it's the familiar trademark of an old employer, and a man runs across it thousands of miles from home.

It means a lot to him then, because he knows first-hand of the skill and experience that went into the manufacture of the product, of the inspections that it went through before it was judged worthy to wear that trademark.

And then he realizes what that name represents—the pride of a manufacturer in a product, confidence in the future of the enterprise. The trademark becomes a symbol of opportunity for the day when men will resume their places once again in a peacetime world.

That's what's in a name—a reminder of the past and a promise for tomorrow.

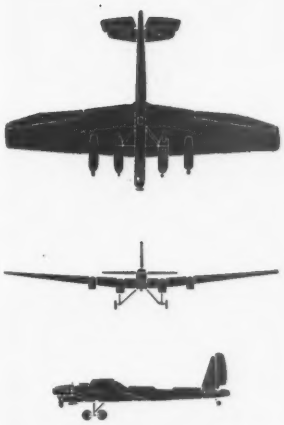
Breeze BREEZE MARK
CORPORATIONS, INC.
NEWARK, NEW JERSEY

PRODUCTION FOR VICTORY • PRODUCTS FOR PEACE

TB-3

An old Toupolev craft originally designed as a bomber, its slow speed has probably relegated it more to transport work than as a combat craft. An unusual feature of its fixed landing gear is the tandem arrangement of the wheels. Developed before the days of widespread use of power turrets, armament consisted solely of machine guns mounted on Scarff rings.

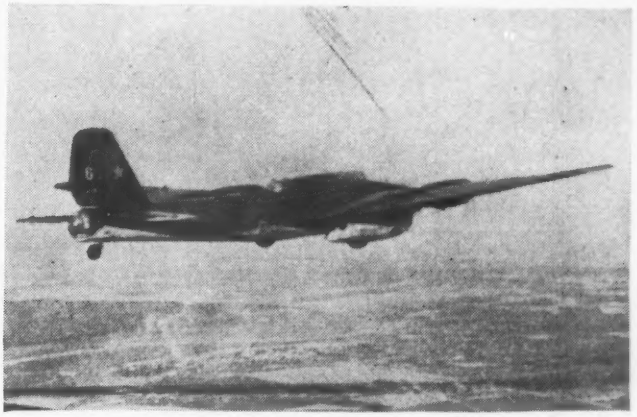
Span .....138 ft.
Length .....87 ft.
High speed .....125 mph.
Cruising speed .....95 mph.
Gross wt.....33,000 lb.
Power .....four 830-hp. Hispano Suiza type M-34's.



TB-7

One of the Soviet's most modern heavy bombers, the TB-7 incorporates several unusual features, outstanding of which is engine coolant system. Radiators for the four engines are combined in the two inboard nacelles, which also house retractable landing gear and, in the rear, gunners' positions. Additional armament is provided in the nose, amidship, and in the tail.

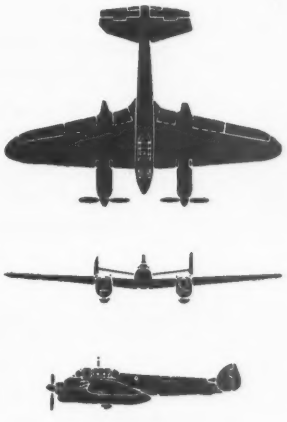
Span .....128 ft.
Length .....75 ft.
High speed .....280 mph.
Cruising speed .....210 mph.
Normal range .....2,500 mi.
Gross wt. (approx.)....50,000 lb.
Power.....four 1,300-hp. AM-38's.

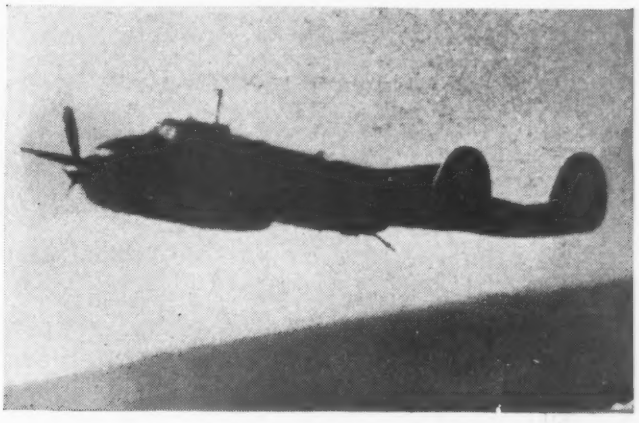


YAK-4

Greatly resembling the PE-2, also an Ilyuchin design, this craft may be basically the same design adapted to different materials, for it is reported to be a combination of both wood and metal construction, a common practice with the Russians. Originally classed as a reconnaissance-bomber, it is said to be equipped with conventional type trailing edge flaps, indicating it is also used for dive bombing.

Span (approx.).....60 ft.
Length (approx.) .....45 ft.
Height (approx.) .....13 ft.
High speed (approx.)....300 mph.
Power.....two 1,100-hp. M-105's.

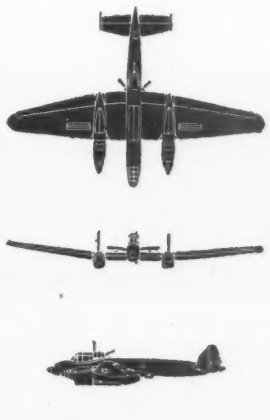


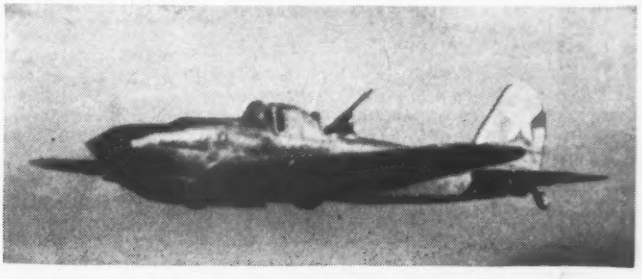


PE-3

Sometimes referred to as the PE-2B, the PE-3 is a fighter-bomber version, and development of the PE-2. It is slightly smaller, having about 3½ ft. less span and being about 6 ft. shorter, and it has no bombardier's window in the nose. The other principal difference is in the installation of a power gun turret just aft of the pilot's enclosure. Other armament includes side guns just aft of the wing, a ventral turret, and probably nose guns.

Span .....56 ft. 5 in.
Length .....39 ft. 4½ in.
High speed (approx.)....310 mph.
Service ceiling.....32,000 ft.
Power.....two 1,100-hp. M-103's.



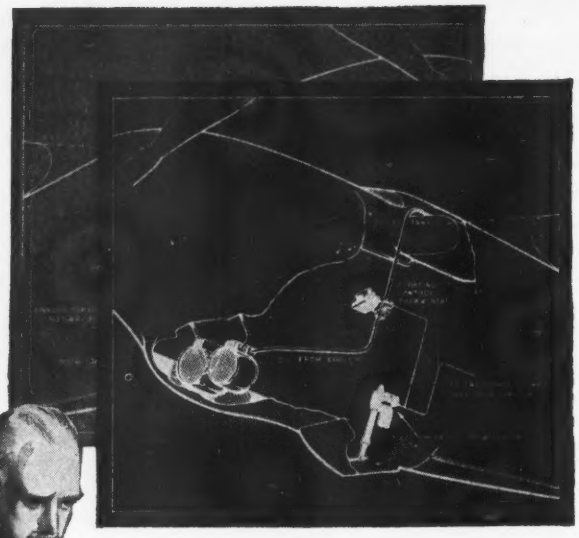


IL-4

Apparently a modification of the famed IL-2 *Stormovik*, the IL-4 is reported to have greater range and increased power. Machine gun, operated by gunner facing aft just behind pilot, appears to be of heavy caliber.

FIRST SUCCESSFUL AUTOMATIC EXIT FLAP CONTROL SYSTEM. AiResearch developed it in 1941. Lightweight, simple in design and made of standard aircraft parts, this electrically-operated system provided a 32° F modulation range between flap open and flap closed.

Advantages: Less instrument watching for pilots. Greater protection for engines. A cut in open-flap time that reduced cooling drag and increased airplane speed.



FURTHER ADVANCEMENT MADE BY "FLOATING CONTROL" (left). An achievement of AiResearch engineering, it enables the thermostat to control the actuator directly—at a rate in proportion to deviation in control point temperature. Through constant temperature control, it reduces open-flap time still more. And provides these—

Additional advantages: An action free temperature band adjustable to meet any requirement—eliminating unnecessary actuator operation near control point. Weight-savings up to 20%. Simplified wiring. And no vibration-sensitive contacts . . . no relays or follow-ups.

Now A NEW AiResearch-designed ACTUATOR

Being "first" to develop new systems is not enough. Constant changes in aircraft design bring greater demands—call for constant improvement of even the finest equipment.

The new actuator for AiResearch Automatic Exit Flap Control Systems meets such a challenge. Developed for a newer and bigger American bomber, it provides advantages for all aircraft.

SIMPLIFIED MAINTENANCE. The motor of this improved actuator can be serviced and brushes changed merely by *removing one spring clip!*

HIGHER EFFICIENCY. Actuator is completely spur-geared. Though smaller and 13% lighter, it supplies *three times more horsepower output* . . . moves exit flaps much faster under greater loads. Available for either A. C. or D. C.

DURABILITY. AiResearch's design has proven rugged under the toughest *load tests* . . . under rigid *temperature tests* ranging from -65° F to 175° F. And *life tests* have not been able to wear it out!

Complete information on this latest AiResearch development and its adaptability to all types of aircraft is now available to American aircraft manufacturers and designers.

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"Where Controlled Air Does The Job" • **Automatic Exit Flap Control Systems** • **Engine Coolant Systems** **Engine Oil Cooling Systems** • **Engine Air Intercooling Systems** • **Supercharger Aftercooling Systems**

TB-6B

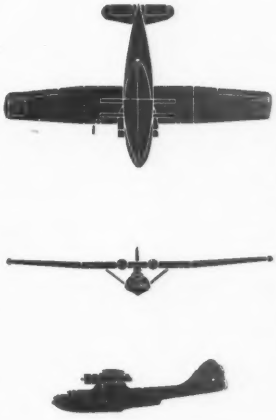
This Toupolev-designed four-engine heavy bomber is a forerunner of the thoroughly modern TB-7. Two unusual features characterize the craft. One is the landing gear, in which the main wheels retract approximately half their diameter into nacelles, or pants. The other is the reported practice of mounting an auxiliary engine within the fuselage to power the four two-stage superchargers.

Span .....120 ft.
High speed .....230 mph.
Max. range.....1,200 mi.
Service ceiling.....26,000 ft.
Gross wt. .....50,000 lb.
Bomb Load .....6,000 lb. +
Power.....four 1,100-hp. Hispano Suiza type M-100's.

GST

Russian designation for the Consolidated-designed PBY *Catalina*. First of the craft to go in service with the Russians were those exported from this country; others were built in the Soviet Union under license.

Span .....104 ft.
Length .....63 ft. 10 in.
Height .....18 ft. 11 in.
High speed .....193 mph.
Cruising speed .....125 mph.
Max. range.....3,100 mi.
Gross wt. .....35,000 lb.
Power.....two 1,200 hp. P & W *Twin Wasps.*



SB-RK

A modification of the SB-3 used largely for dive bombing. This version appears to have slightly better performance through design refinements, which always accompany development of a basic type. It also benefits from an increase of approximately 300 hp. Both types utilize Junkers type dive brakes.

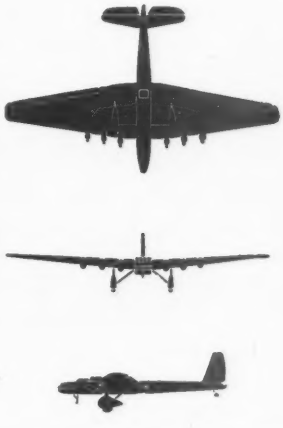
Span.....70 ft. 6 in.
Length .....40 ft.
High speed.....over 280 mph.
Cruising speed.....over 220 mph.
Power.....two 1,100-hp. Hispano Suiza type M-105's.

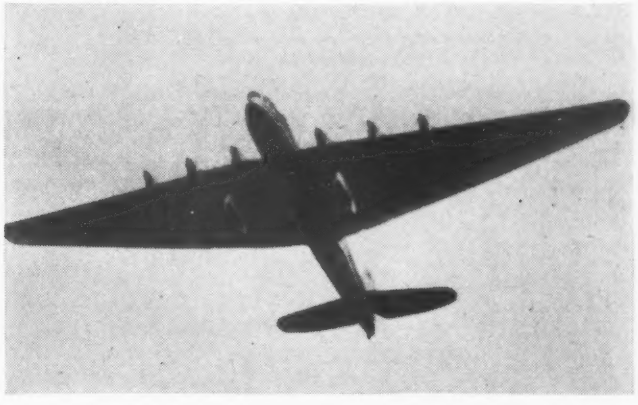
Cargo Transport

L-760

Another of the prolific Toupolev's designs, this six-engine craft was originally developed as a commercial transport to accommodate 64 passengers. One of the world's largest aircraft, its 210-ft. span is but 2 ft. less than that of the American-built Douglas B-19. An indication of the L-760's size can be had from the fact that the fixed landing gear wheel spats are nearly 15 ft. in height.

Span .....210 ft.
Length .....112 ft.
High speed.....185 mph.
Normal range.....1,860 mi.
Gross wt. .....103,000 lb.
Power.....six 1,100-hp. Hispano Suiza type M-100's.



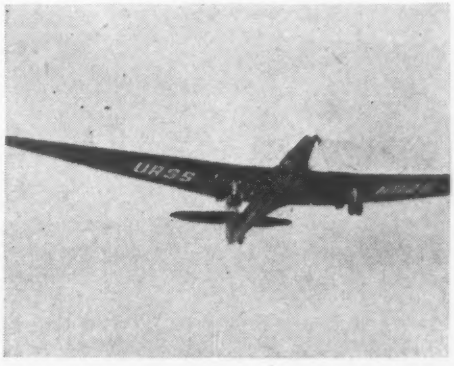


TB-1

An early fixed-landing-gear twin-engine medium bomber distinguished by "overhanging" ailerons and elevators. Armament consists of machine guns in nose, dorsal, and ventral positions.

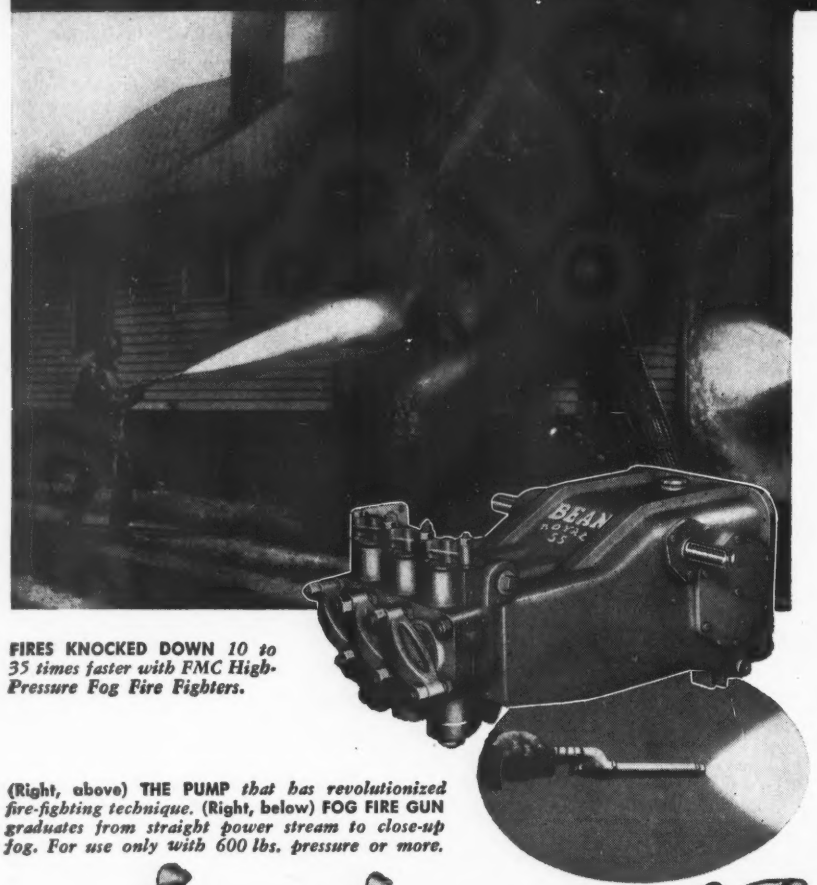
ANT-25

Long-range single-engine reconnaissance freight developed from the prototype (shown here) which flew non-stop across the Arctic to Southern California several years ago.



YOU MUST HAVE 800 LBS.

for High-Pressure Fog Fire Fighting!



FIRES KNOCKED DOWN *10 to 35 times faster with FMC High-Pressure Fog Fire Fighters.*

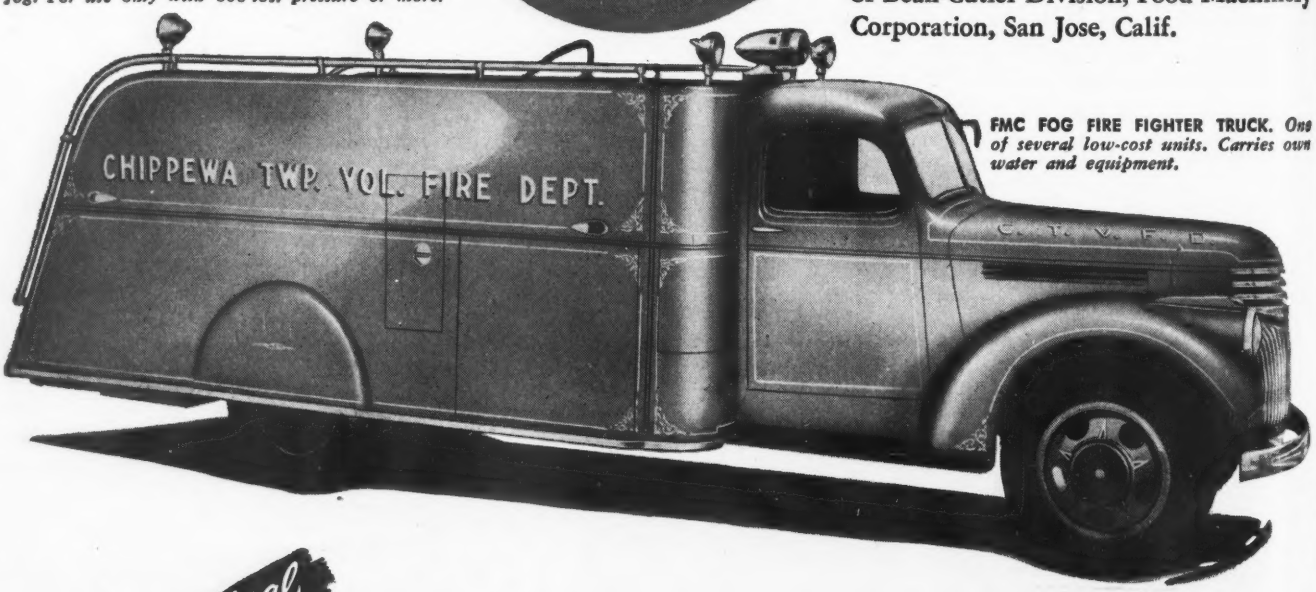
(Right, above) **THE PUMP** *that has revolutionized fire-fighting technique.* (Right, below) **FOG FIRE GUN** *graduates from straight power stream to close-up fog. For use only with 600 lbs. pressure or more.*

Only FMC Packs Needed Punch to Hold 600-lbs. Nozzle Pressure

The heart of the FMC Fog Fire Fighter is its exclusive high-pressure pump. It easily develops 600-lb. nozzle pressure, and breaks up water so fine that one gallon, properly used, can give you the fire-quenching efficiency of 35 low-pressure gallons.

If *pump* pressure is not high enough to start with, it is not possible to get the 600-700 lb. nozzle pressure that is needed to deliver the superfine FMC fog that puts out fires so fast with no water damage and no water shortage.

Proved on hundreds of fires all over the country, FMC High-Pressure Fog Fire Fighters are not to be confused with any other method. There is nothing comparable to them. Write for full details to John Bean Mfg. Co., Lansing, Michigan, or Bean-Cutler Division, Food Machinery Corporation, San Jose, Calif.



FMC FOG FIRE FIGHTER TRUCK. *One of several low-cost units. Carries own water and equipment.*

FMC *Original* HIGH-PRESSURE FOG FIRE FIGHTER

FOOD MACHINERY CORPORATION

JOHN BEAN MFG. CO., 705 HAZEL ST., LANSING 4, MICH. • BEAN-CUTLER DIVISION, 405 JULIAN ST., SAN JOSE, CALIF.

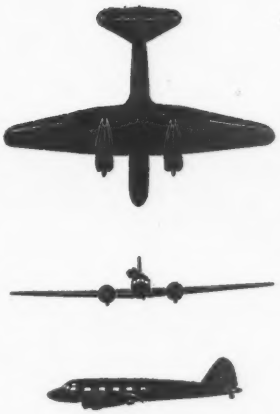
BUILDERS OF BEAN HIGH-PRESSURE PUMPS FOR OVER 50 YEARS

Russian

PS-35

Developed in 1936, this civil transport has been converted to wartime passenger and cargo service. Although it is somewhat smaller, it appears to have many characteristics of the American-built Douglas DC-2 which preceded it a few years. Unlike many Russian craft which are combination metal and wood, the PS-35 is of all-metal construction.

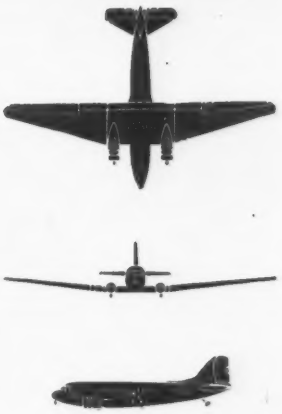
Span .....68 ft. 2 in.
Length .....49 ft. 2 in.
High speed .....250 mph.
Gross wt. .....14,500 lb.
Power.....two 850-hp. Gnome-Rhone type M-85's.



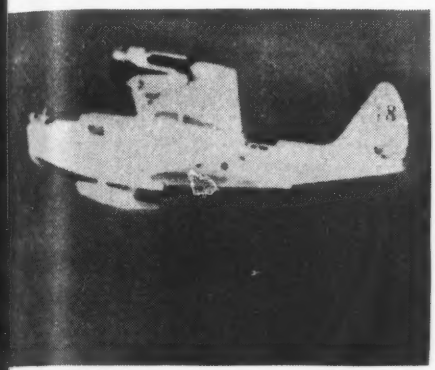
PS-84

Russian designation for the old reliable "workhorse," the Douglas DC-3. Used not only for cargo and personnel transport work behind the lines but also to "deliver" paratroops. The Russians are understood to have installed several side-firing machine guns. The craft was built in the Soviet Union under license.

Span .....95 ft.
Length .....64 ft. 6 in.
Height .....16 ft. 11in.
High speed.....230 mph.
Cruising speed .....185 mph.
Gross wt. .....26,000 lb.
Power.....two 1,100-hp. M-63's.



Reconnaissance



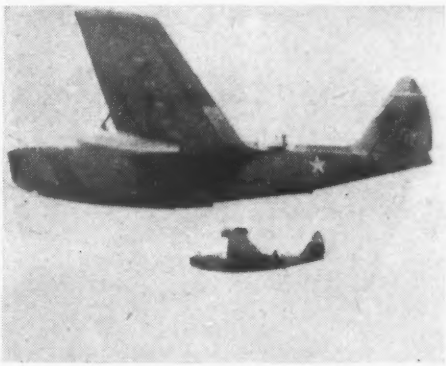
MR-5

Greatly resembling MBR-2 reconnaissance flying boat, principal difference in this craft appears to be in use of radial aircooled engine—probably of greater horsepower—in place of inline liquid-cooled engine.

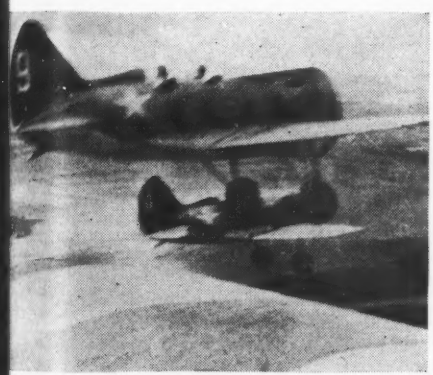
MBR-2

Three-place single-engine reconnaissance flying boat, apparently built specifically for patrol work in Black and Baltic seas.

High speed.....120 mph.
Normal range.....620 mi.
Power.....One 680-hp. M-17



Trainers

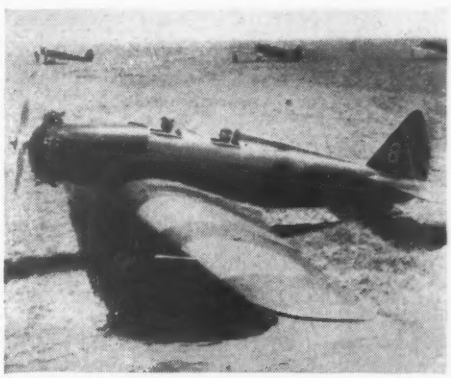


I-16B

Famed, but now obsolete, I-16 *Rata*, with an extra seat converting it to a fighter pilot transition trainer, such as has been done in this country with the Lockheed P-38 *Lightning* "piggy back" version and the Bell TP-39 *Teepee*.

Primary Trainer

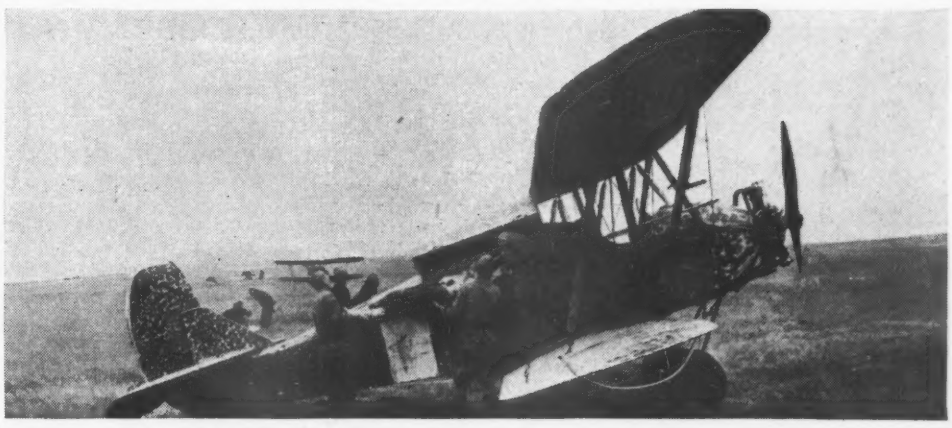
Bearing quite a resemblance to the American Kinnercraft of the early 50's, this U-type plane is widely used for primary flight training all over the Soviet Union.



U-2 Utility Trainer

An old, old timer, still serving as everything from a primary trainer through ambulance craft to a night glide bomber. Its ruggedness and low speed permit it to land in otherwise inaccessible areas for evacuation of wounded, and this same speed has, on occasion, fooled Nazi anti-aircraft batteries until it was too late.

Span .....37 ft. 5 in.
Length .....26 ft. 8 in.
Height (approx.).....12 ft.
High speed .....93 mph.
Normal range .....250 mi.
Gross wt. .....1,892 lb.
Power.....one 110-hp. M-11.



John C. Mason ... FREE AMERICAN

This is my signature—the signature of a free American. This signature helped me to buy a home. The same signature bought my car. It means something in the local bank and stores; and it secured hospital care for my little girl when I didn't have the cash.

That's why I am proud of my signature and glad that, as an American, I have been free to work where I wanted, to buy what and where I wanted, and to do those things that make my signature more than simply "ink on paper."

Giving up some of this freedom temporarily during the war isn't so bad—but I'm putting extra effort into my job to help win the war and get us all back to peacetime American ways.

The name John C. Mason might well be the name of any one of a large number of "Michigan" employees. For many years this group of people has helped build the reputation of our company name and trademark.

Although today our entire output is supplied under directives, we still strive to deliver products and service that build respect for our own signature.

And, like John C. Mason, we add an extra effort to speed the day when we shall again be permitted to take our part in a free, unhampered, competitive American industry.

KEEP AMERICA, AMERICAN

MICHIGAN TUBING

ARMY E NAVY

Awarded Feb. 12, 1943

First Star Sept. 9, 1943

MICHIGAN SEAMLESS TUBE COMPANY

SOUTH LYON • MICHIGAN

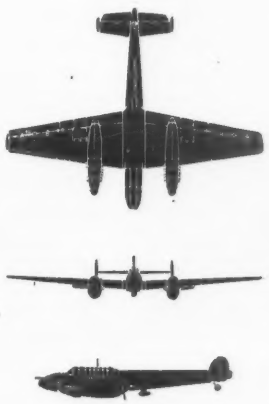
Fighters

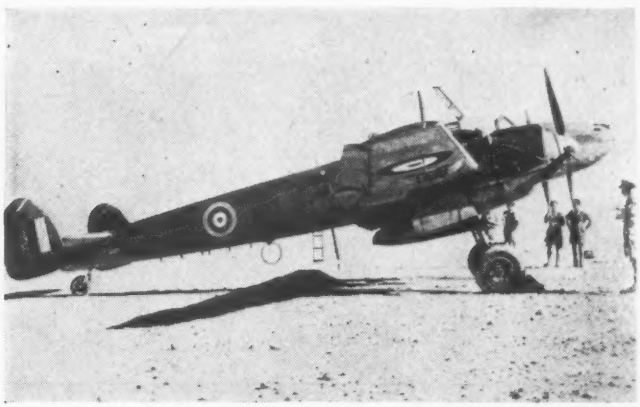
Messerschmitt Me-109G

One of Luftwaffe's old fighter standbys, this single-seater is still no match for latest Allied pursuit planes, such as *Spitfire* and *Thunderbolt*. Latest improvements in this mark over Mark F include new 1,600-hp. MercedesBenz engine and pressure cabin for high altitude work. Armed with two 20-mm. wing cannons, two 7.9-mm. guns in cowl, and possibly two or more wing guns. Service ceiling is about 40,000 ft.

Span.....32 ft. 8½ in.
Length.....29 ft. 8 in.
Height.....8 ft. 6 in.
High speed.....390 mph.
Max. range.....420 mi.
Gross wt.....6,820 lb.
Power.one 1,600-hp. Mercedes-Benz

Messerschmitt Me-110C5

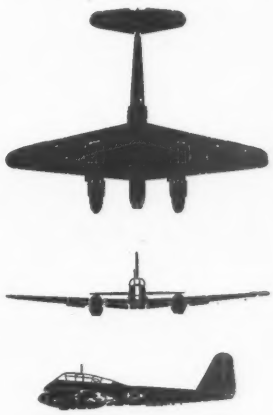


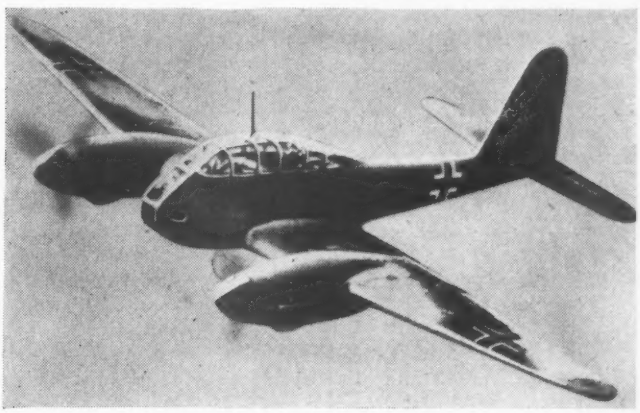


The Germans originally intended this twin-engine plane for fighter escort service, but it soon proved more vulnerable than the Me-109. Equipped with extra fuel tanks, armed with four 7.9-mm. machine guns in the nose and a flexible rear cockpit mount, and carrying two 551-lb. bombs, it has been pressed into service as a long-range fighter-bomber on every front.

Span .....53 ft. 5 in.
Length .....40 ft. 6 in.
Height .....10 ft. 9 in.
High speed.....365 mph.
Max. range.....1,500 mi.
Gross wt.....15,300 lb.
Power.....two 1,200-hp. Daimler-Benz.

Messerschmitt Me-210

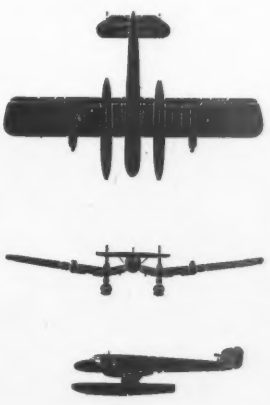


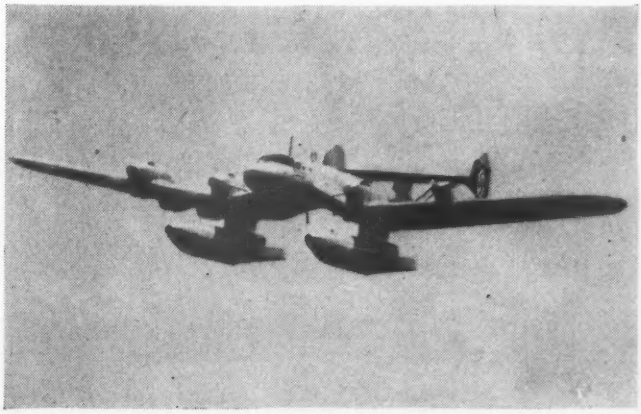


Primary difference between this two-seat attack bomber and its predecessor, ME-110, is increased range and bomb capacity of 2,000 lb. Though speed and climb have been sacrificed for these two features, it is heavily armed with two nose cannons and four new, heavy-caliber machine guns in front and in remote controlled barbettes on both sides of fuselage for rearward firing guns.

Span .....53 ft. 6 in.
Length .....36 ft. 4 in.
High speed.....368 mph.
Max. range.....1,700 mi.
Gross wt.....18,000 lb.
Power.....two 1,400-hp. Daimler-Benz.

Blohm & Voss BV-139B





A development of an earlier type used in transocean service with German airlines. Designed mainly for reconnaissance and mine laying work, it has also occasionally served as an ambulance plane. Trim looking with long, thin fuselage, it displays unique design feature in tubular, mono-spar wing construction. Fuel and oil are stored entirely in hollow, single wing spar.

Span.....80 ft. 7 in.
Length.....64 ft. 6 in.
Height.....14 ft. 7 in.
High speed.....202 mph.
Max. range.....3,230 mi.
Gross wt.....38,610 lb.
Power..four 600-hp. Junkers Jumo.

America's Radial Air-cooled Diesel Engine

Guiberson's present world leadership in the field of radial diesel engineering began more than fourteen years ago when Guiberson engineers developed the world's only high-speed air-cooled radial diesel engine. Eleven years ago the first Guiberson-powered plane took to the air and the first A.T.C. certificate for the Guiberson radial diesel engine was granted. Eight years ago the first Guiberson radial diesel took its place in the tanks of our first armored force. Today the Guiberson radial diesel engine provides dependable, low-cost, fire-safe power that will help America win the edge that is needed for victory—and it is the power plant that will win leadership for America in the field of post-war transportation on land, on sea, and in the air!

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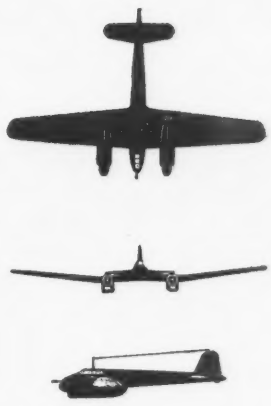
GUIBERSON DIESEL ENGINE COMPANY
Dallas, Texas

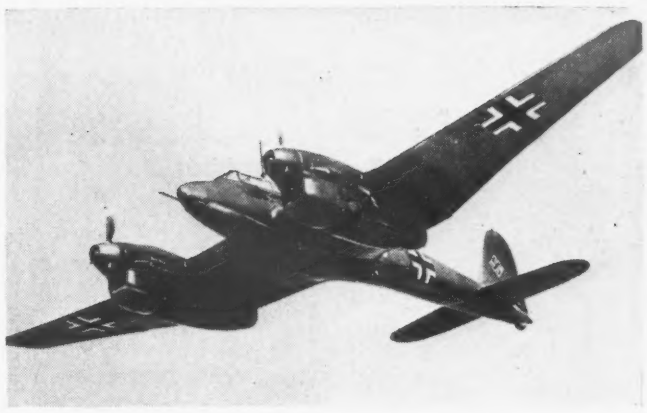
THE GUIBERSON CORPORATION
Aircraft and Heater Division

Focke-Wulf FW-187

earing some semblance to the Me-10, this twin-engine two-place interceptor has not been seen in very rge numbers to date. A cleanly ilt fighter, it is reported to have maximum range with special uipment of 1,500 mi. Armed with vo 20-mm. cannon and four ma-ine guns in the nose. Service iling of 38,700 ft. Carries several ght bombs externally.

pan .....51 ft.
ength .....33 ft.
igh speed.....395 mph.
ax. range.....1,500 mi.
ross wt.....14,000 lb.
ower....two 1,400-hp. Mercedes-Benz.

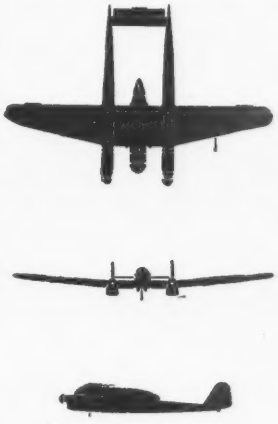


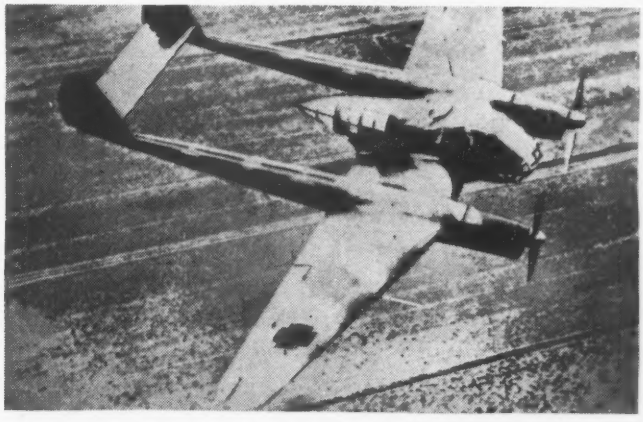


Focke-Wulf FW-189

peculiar twin-boom twin-engine econnaissance fighter powered by mall Argus aircooled engines. otal 900 hp. gives this three-place lane a top speed of only 222 mph. rew's shell accommodates pilot nd navigator side by side and gun-er in rear. Photographic equip-ent is carried. Armed with four 9-mm. guns, two firing forward nd two on flexible mounts in rear f pilot's cupola. Used extensively n Russian front, occasionally as mbulance craft with two stretch-rs.

Span.....60 ft. 4 in.
Length.....39 ft. 4 in.
High speed.....222 mph.
Gross wt.....7,480 lb.
Power.....Two 450-hp. Argus.

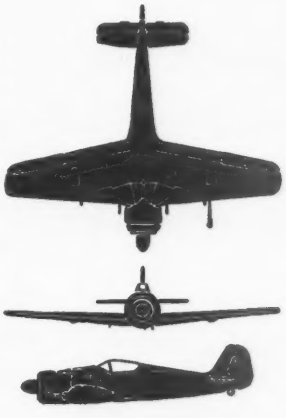


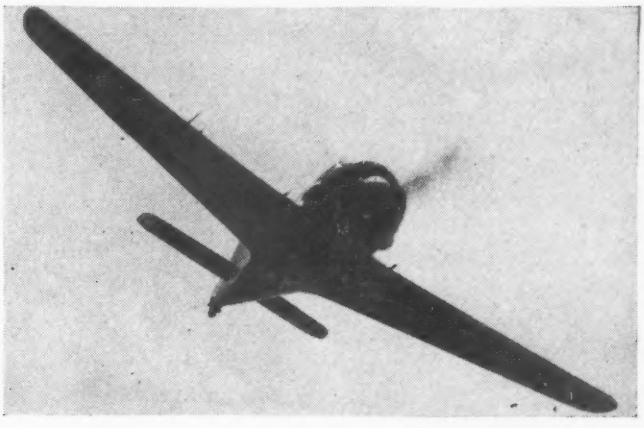


Focke-Wulf FW-190

Although it is the Nazis latest nd best fighter, the FW-190 has ot proved equal to either British r American craft designed for the ame purpose. Appearing early in 941 as an interceptor, it is now sed also as a fighter-bomber, car-ying a 500-lb. missile. The first erman fighter plane to use a adial engine, it has a top speed lose to 400 mph. Armament in-cludes four 20-mm. wing cannons nd two 7.7-mm. machine guns.

Span.....34 ft. 5 in.
Length.....29 ft. 4 in.
High speed.....390 mph.
Max. range.....520 mi.
Gross wt.....9,200 lb.
Power.....one 1,600-hp. BMW.

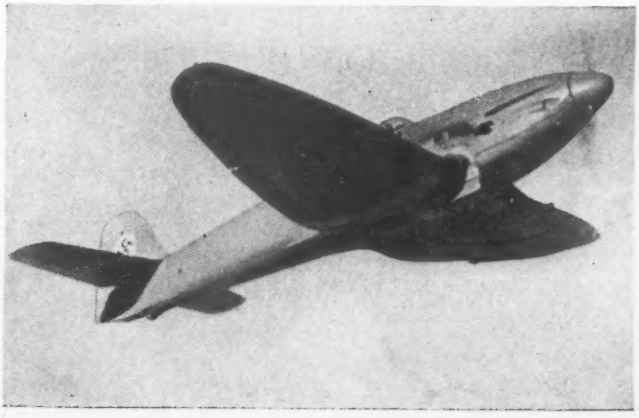


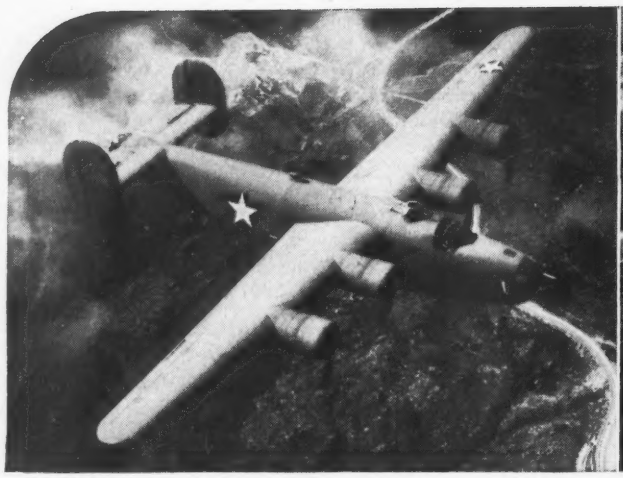


Heinkel He-112

Developed from a German racing plane, this single-place fighter is one of the fastest craft in the Luftwaffe. However, it has not been widely used in any major theater. An attempt was made to improve maneuverability by using inwardly retracting landing gear and moving the two 12.7-mm. guns toward the wing roots so as to concentrate weight.

Span.....29 ft. 10 in.
Length.....29 ft. 6 in.
Height.....12 ft. 1 in.
High speed.....358 mph.
Max. range.....715 mi.
Gross wt.....5,740 lb.
Power..one 1,070-hp.Daimler-Benz





Consolidated's B-24 "Liberators"

Martin's PBM "Mariners"

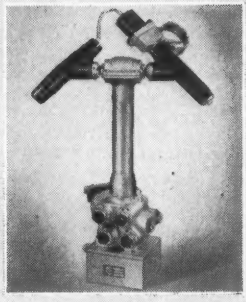
Clarke-Aero

Hydraulic Gun Turret Control Valves

★ Smooth, Positive Control

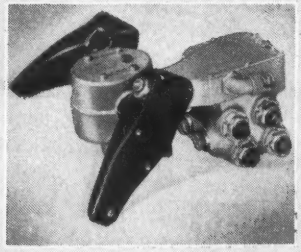
★ Ease of Adjustment

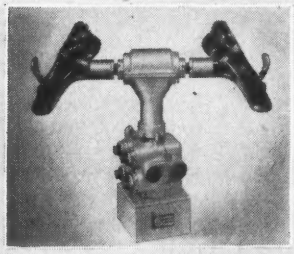
★ Definite Feel



THESE qualities as found in the Clarke Aero-Hydraulic Gun Turret Control Valve account for the effective fire power obtained in turrets using the Clarke Valve. The design of the valve is such that it affords maximum flexibility as to mounting position, length of column and style of grips.

This flexibility of design makes the valve adaptable to a wide variety of turret installations.





Adaptable: Fits wide variety of turrets.

CLARKE AERO-HYDRAULICS, INC.

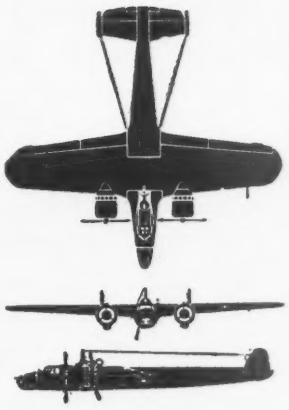
PASADENA · CALIFORNIA

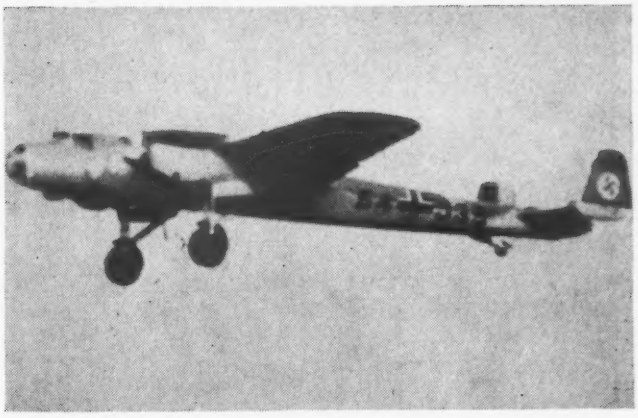
Bombers

Dornier Do-17Z

Predecessor of the Dornier Do-217, this twin-engine four-man plane has served widely, both as a medium bomber carrying a 2,200-lb. pay load and as a reconnaissance plane equipped with three automatic cameras. Well armed with five 7.9-mm. guns mounted in the glass-enclosed cupola and one 20-mm. cannon in nose. Carries extra gas tanks for long-range reconnaissance duties.

Span.....59 ft.
Length.....53 ft. 5 in.
Height.....15 ft. 9 in.
High speed.....275 mph.
Normal range.....745 mi.
Gross wt.....19,481 lb.
Power.two 1,000-hp. Bramo Fafnir

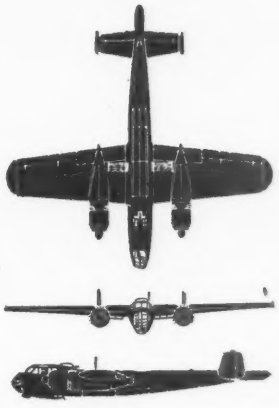


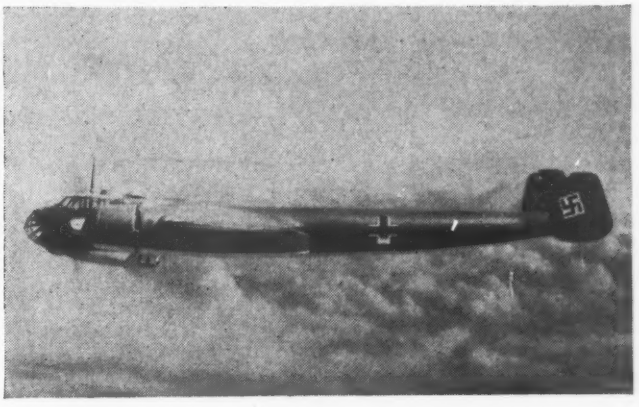


Dornier Do-217E

A development of the earlier Do-17Z as a multi-purpose medium bomber, dive bomber, night fighter, and reconnaissance airplane. Features include retractable umbrella dive brake on tail, Handley-Page wing slots and Mercier type cowls with sliding ring air-cooling control. Bomb capacity of 6,600 lb. Crew's cupola carries six machine guns and two 20-mm. cannon. Reported to carry heavy loads with rocket-assisted takeoff.

Span .....62 ft. 5 in.
Length .....56 ft. 6 in.
High speed.....324 mph.
Max. range.....1,500 mi.
Gross wt.....34,000 lb.
Power.....two 2,000-hp. BMW.

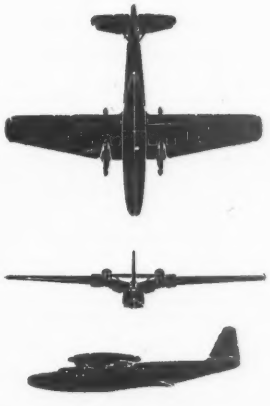


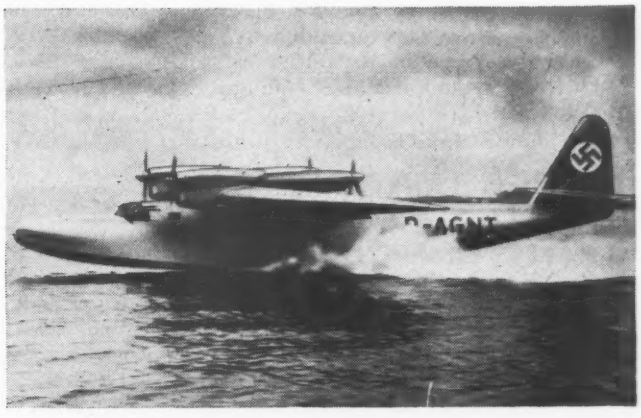


Dornier Do-26

A military conversion of the Deutsche Lufthansa transport. As a long-range reconnaissance craft, it has proved an efficient, dependable plane. Employs retracting floats in place of customary Dornier sponsons. Two rear nacelles of four-engine tandem are elevated slightly to avoid water spray during takeoff. Armament consists of one 23-mm. nose cannon, two guns in side blisters. Bomb load, 1,000 lb.

Span.....98 ft. 6 in.
Length.....80 ft. 6 in.
Height.....22 ft. 6 in.
High speed.....208 mph.
Max. range.....5,600 mi.
Gross wt.....50,000 lb.
Power..four 750-hp. Junkers Jumo

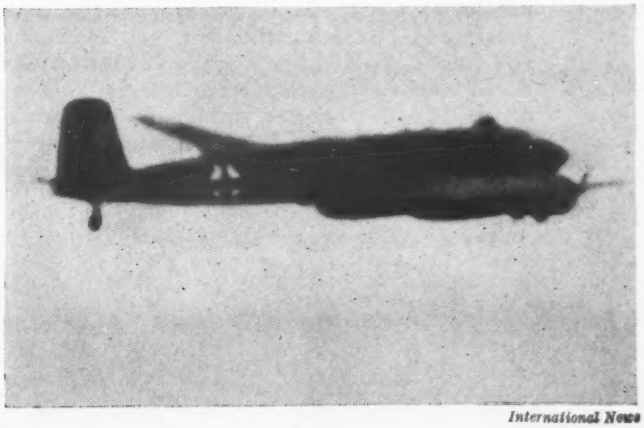




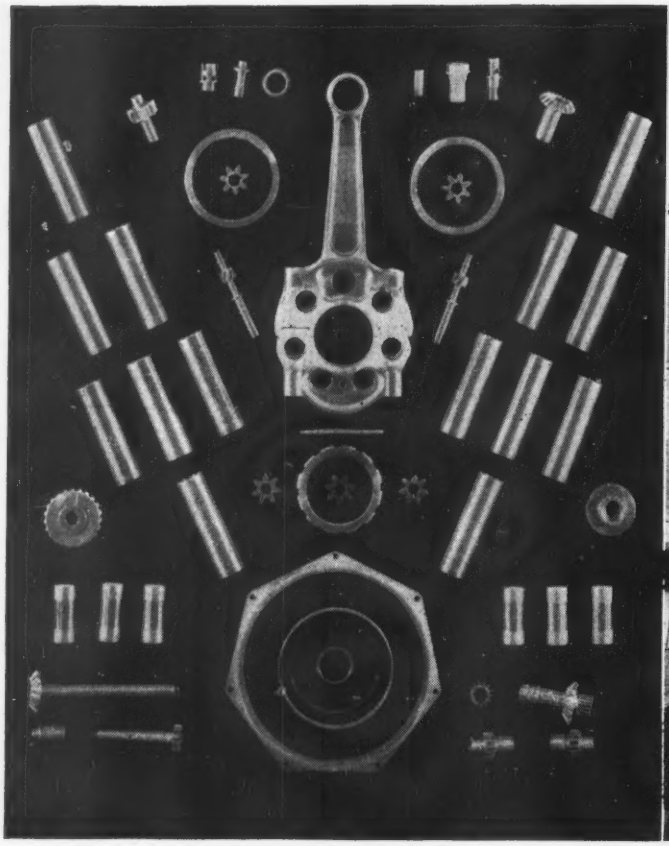
Focke-Wulf FW-200K *Kurier*

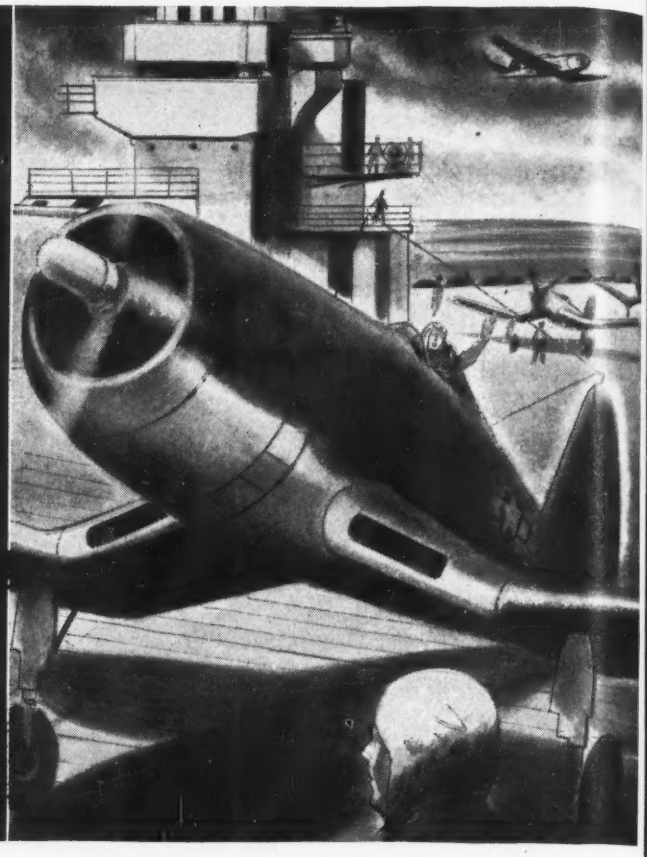
One of the worst threats to Allied shipping when teamed with the submarine, these long-range planes have proved no match for the heavier-gunned, more maneuverable Consolidated B-24 *Liberators*. As a seagoing reconnaissance bomber, it carries one flexible 20-mm. nose cannon, eight 7.7-mm. machine guns in front, belly, and dorsal turrets. Bomb load is 6,600 lb.

Span.....108 ft.
Length.....78 ft. 2½ in.
Height.....20 ft.
High speed.....279 mph.
Max, range.....3,000 mi.
Gross wt.....48,500 lb.
Power.....four 1,320-hp. BMW.



International News





Together They Spell V-I-C-T-O-R-Y

LOOK OVER THE EDGE of a carrier's flat top, or stand on the side of a jungle clearing when the incisive, urgent demand to *"Scramble!"* sends the world's finest pilots into the cockpits of Corsairs, Hellcats, or Thunderbolts. You'll understand why it goes without saying that every pilot appreciates the mechanical marvels of these battle planes. Catch that grim, yet confident smile that touches their lips as they "pour on the coal" and "rev" up their 2000 horsepower Wasps. It's the acid test. And as those daredevil kids hit the blue with a nonchalant flip of the mitt, you feel that the greatest support to their courage is their confidence in the caliber of craftsmanship which made the power plants in their planes possible.

An aircraft engine manufacturer must be master of the infinite. Exquisite precision in all manufacturing and assembly operations must ever be his goal—for the challenge in making an engine like the 2000 horsepower Double Wasp is this . . . to preserve . . . by delicate accuracy of manufacture and finish . . . all of the inherent strength and endurance in every ounce of material used. This need for perfection is not new to McAleer. For years it has been our special province to develop materials and methods for finishing metals with precision and lapidarian skill. In today's tasks we are benefitted by all that 18 years of manufacturing experience in the development of *quality-controlled* finishing materials and job-proven finishing methods has to offer. These facilities we gladly place at your disposal.

Because this company makes buffing, polishing and burring compositions in the broadest range, we are qualified to offer you unbiased advice and to formulate the most desirable type of finishing material required to handle your specific job.

Your war-time finishing problem may not be as tough as that presented by the finishing requirements of the above aircraft engine parts where the micron finish had to meet the toughest of Army and Navy specifications—then again, in its own way, depending on the job to be done, whether that job involved the polishing or buffing of aluminum, brass, steel, copper, nickel, chrome and other metals, or even plastics—it may be tougher to lick. In any event if it's got you stumped—we'd like a try at it. We'll let results speak for themselves! It is our privilege to continue to work closely with many of America's leading War Materiel producers—they, you and we have but one job to do until victory is won. *Let's get on with it!*

McAleer MANUFACTURING CO.

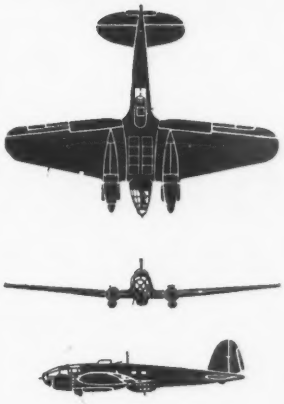
Manufacturers of Quality-Controlled Finishing Materials, Military Aircraft Sub-assemblies and Pyrotechnics ! ! !

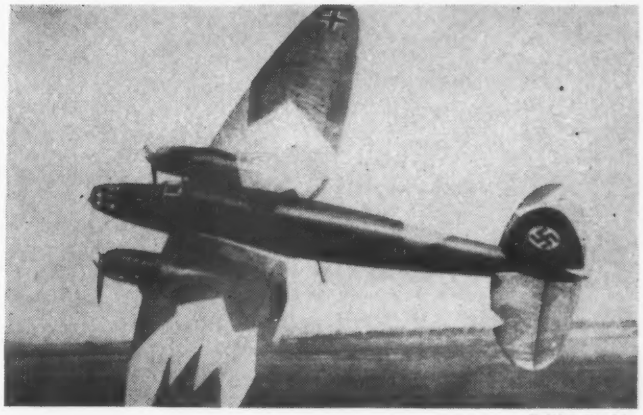
ROCHESTER, MICHIGAN

Heinkel He-111K5A

ermany has gone far in the de-lopment of twin-engine utility mbers since this craft's prototype peared in the Spanish Civil War. w obsolete by Allied standards, is still used for torpedo attacks as a glider tug. Lightly armed th 20-mm. cannon in nose, five 9-mm. machine guns in front, top, le and belly blisters. Carries ht 550-lb. bombs or two 1,740-lb. rpedoes.

pan.....74 ft. 3 in.
ength.....54 ft. 6 in.
eight.....13 ft. 9 in.
igh speed.....274 mph.
ax. range.....2,140 mi.
ross wt.....25,000 lb.
ower.two 1,200-hp. Junkers Jumo



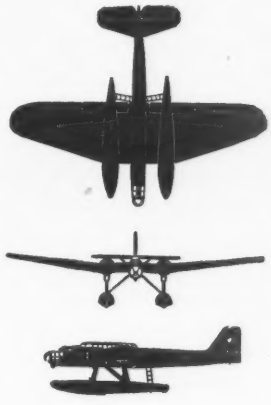


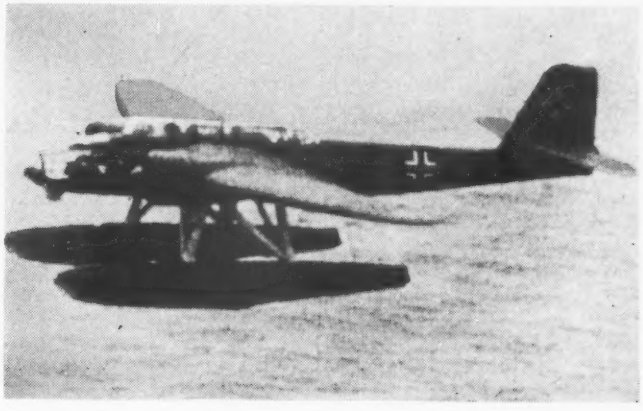
British Combine

Heinkel He-115

esigned primarily for mine laying d torpedo work and used with eat effect against English ship-ng before "degaussing" appeared. hough intended for open-sea duty a three-place float plane, it has so been operated as a land-based aft from snow-covered Russian rfields. Unusual armament com-rises pair of rear-firing, remote-ntrol machine guns in engine celles. Additional complement two guns in cockpit.

pan.....75 ft. 10 in.
ength.....57 ft.
eight.....23 ft. 4 in.
igh speed.....217 mph.
ax. range.....1,305 mi.
ross wt.....20,020 lb.
ower.....two 880-hp. BMW.

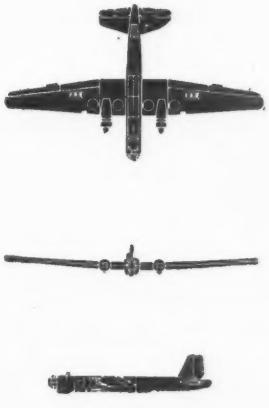


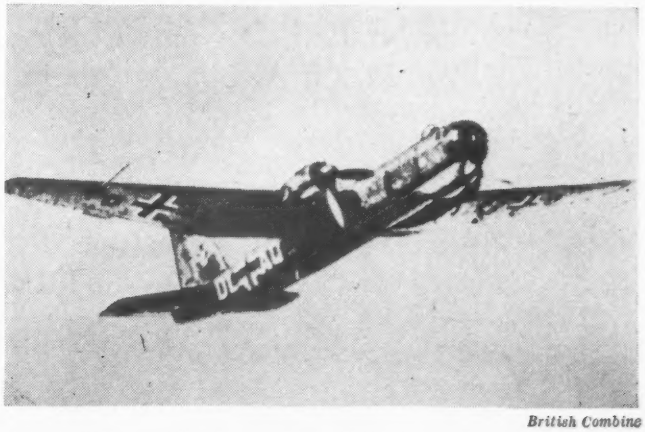


Heinkel He-177

ne of Germany's newer and better mbers, the He-177 is well ahead other Nazi types with a reputed 000-mi. range, without, of course, y bomb load. Approximately as rge as a *Flying Fortress*, it ounts two propellers driven by ur engines. Other unusual fea-res include venetian blind type ve brakes and tail cannon. Gun sitions in nose and around fuse-ge.

pan.....103 ft. 4 in.
ength.....67 ft. 3 in.
eight.....18 ft. 2 in.
igh speed.....280 mph.
ormal range.....2,795 mi.
ross wt.....71,600 lb.
ower.....four 1,600-hp. BMW



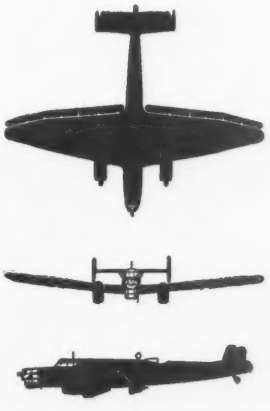


British Combine

Junkers Ju-86

he earlier K model exported to outh Africa before the war caused me confusion in early raids on ermans in East Africa. Poorly med and carrying a scant 500 lb. bombs, it was replaced by the ark P series equipped with turbo-upercharged engines and pressure bin for high altitude work (45,000). Two variations of this model, 1 and P2, appear as reconnais-nce plane and bomber.

pan.....84 ft.
ength.....53 ft.
eight.....15 ft. 8 in.
igh speed.....275 mph.
ax. range.....1,500 mi.
ross wt.....22,900 lb.
ower.two 1,000-hp. Junkers Jumo.



British Combine

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"Git Thar Fustest with the Mostest" is as sound a formula for winning battles today as it was when General Nathan Bedford Forrest uttered these words during the Civil War. The only difference is that today they apply to bombing planes instead of men.

As Allied bombers swarm over enemy territory in ever-increasing numbers, we take pride here at General Engineering in the part ★General★ Riveters are playing in helping to speed final Victory. With hundreds of thousands of rivets going into every bomber, the adaptation of the multiple riveting principle to heavy bomber sub-assemblies is an important factor in getting these bombers into the air days earlier. Wing skins, spars, rudders and other heavy sub-assemblies are being riveted from 200% to 500% faster on ★General★ Multiple Riveters.

Just as ★General★ engineers have kept pace with new developments in aircraft production, so will they adapt ★General★ riveters to the post-war needs of industry. Consider multiple riveting in your post-war planning.

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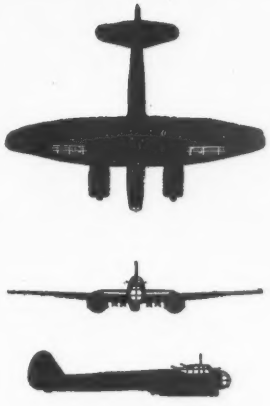
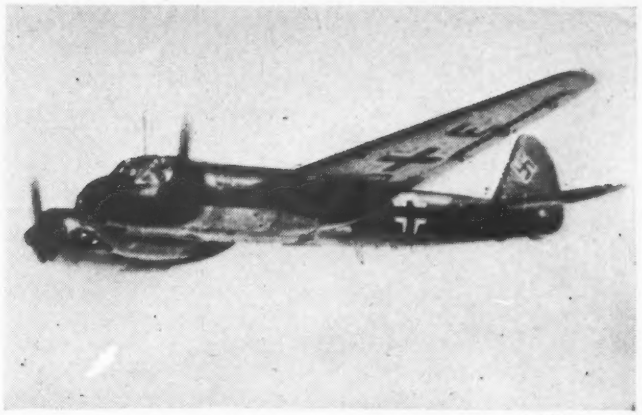
Junkers Ju-88A6

erally a jack-of-all-trades, this r-man twin-engine bomber has n used for a wide variety of ks. Better than famed *Stuka* a dive-bomber, it is also used a night-fighter with a forward ttery of guns and cannon. A d example of German theory of ncentrating crew in nose of plane. her notable features are circular eling for in-line engines and haust gas de-icer. Carries three -mm. guns, one 20-mm. cannon.

n.....60 ft. 3 in.
ngth.....47 ft. 1 in.
ight.....15 ft. 5 in.
gh speed.....317 mph.
x. range.....2,520 mi.
oss wt.....27,060 lb.
wer.two 1,200-hp. Junkers Jumo



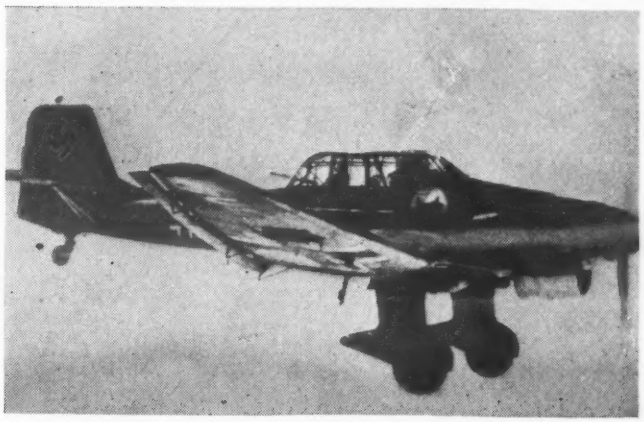


British Combine

Junkers Ju-87D *Stuka*

d remains of what once terror- d the defenseless Low Countries. recent battles over Rhodes, U. S. *ghtnings* have accounted for ole fleets of these planes. Though dified for use in the Russian mpaign, it is still slow and eatly underarmed. Carries two nt machine guns in cowl, one xible gun in rear cockpit, and 00-lb. bomb.

an.....45 ft. 4 in.
ngth.....35 ft. 6 in.
ight.....12 ft. 9 in.
gh Speed.....250 mph.
x. range.....360 mi.
oss wt.....9,300 lb.
wer.one 1,200-hp. Junkers Jumo

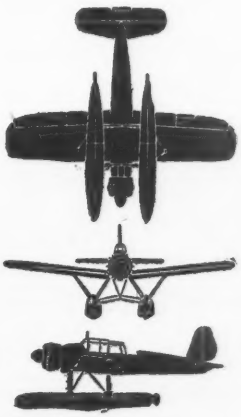


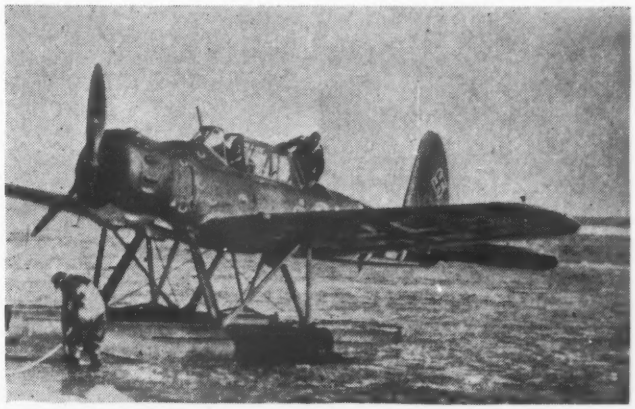
British Combine

Arado Ar-196A

ndard catapult plane of the rman navy, this two-seat re- naissance-bomber is badly de- med, as the battles of the *Graf ee* and *Bismarck* showed. Though avily armed with two cannon, o guns in nose, and one flexible unt in rear cockpit, it carries ly two light bombs and has poor rformance. Slow, with a climb- rate of only 980 fpm., it has come easy prey for Allied craft.

an.....49 ft. 6 in.
ngth.....38 ft. 6 in.
ight.....16 ft. 5 in.
gh speed.....193 mph.
x. range.....670 mi.
oss wt.....8,200 lb.
wer..one 920-hp. Bramo Fafnir

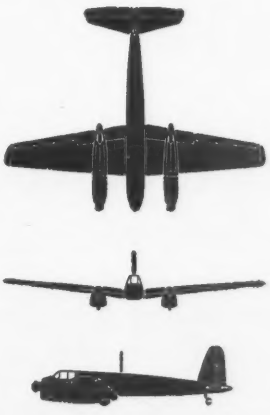


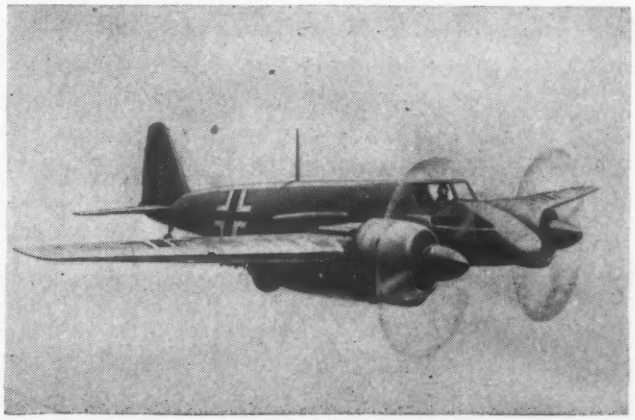


Henschel Hs-129

parently impressed by the fa- us Russian tank-busting *Stormo-* , the Germans were quick to pt the Hs-129 as a low-level ack-bomber. Used in the Afri- campaign in an effort to check lied armor, it failed to meet the rk. It is well armed with two -mm. cannon in nose and one -mm. belly cannon which can be placed by a 550-lb. bomb. Slow d under-powered, it reveals inter ing German trend toward use of hp. engines in the combat nes.

an.....44 ft. 6 in.
ngth.....33 ft. 3 in.
gh speed.....285 mph.
oss wt.....9,000 lb.
wer..two 650-hp. Gnome-Rhone





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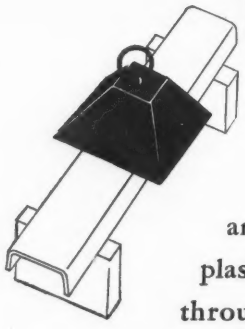

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1925 Exides EXPLORE New Guinea

1944 Exides FIGHT there now

Back in 1925, an American Expedition flew by plane into the dense, tropical jungles of Dutch New Guinea to gather information on an ancient, primitive race of pygmies. A similar expedition by land had been attempted but, due to density of jungles and hostility of natives, was only partially successful.

Aviation engineers learned valuable lessons from this pioneer flight . . . and Exide engineers gathered important data from the rugged performance of the Exide with which the Expedition was equipped.

Today, in those same steaming jungles, our fighting men have proven the great advantage of air power in jungle warfare strategy. The groundwork laid by the aviation pioneers of the 20's contributed greatly to successes today. Everyday, planes carrying Exide Batteries, seek out the Jap and drive him to the sea. Years of research, in the field and in the laboratory, plus the work of plane engineers, manufacturers, and the Engineering Divisions of the Armed Forces, have resulted in these rugged new Exides. You'll find them in most of America's leading planes. Ask the boys in the ground crews. They *know.*

THE ELECTRIC STORAGE BATTERY CO., Phila. 32

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Among the many letters we receive daily from over 1200 former Exide employees in the Service, was this interesting note from one of our boys at the front:

"I want to tell you what an important role Exides play in Radar. When the batteries go dead the Radar equipment is absolutely worthless. Fortunately, we haven't had any trouble with our battery as yet. You guessed it . . . it's an Exide. With the good work the boys are doing back at the plant, I'm sure we won't have any trouble."

ARMY E NAVY

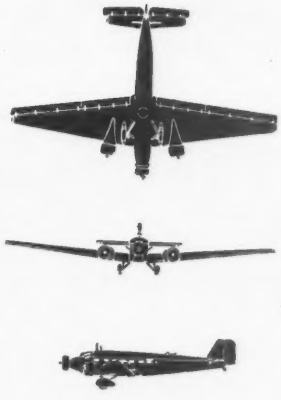
Exide

AIRCRAFT BATTERIES

IN THE AIR SINCE 1917

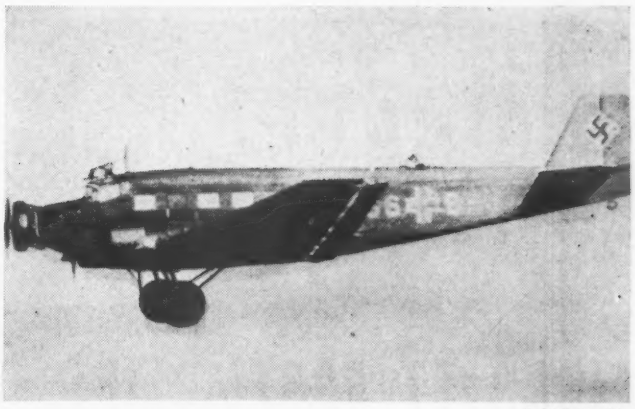
Cargo Transport

Junkers Ju-52



A venerable work-horse of the German Luftwaffe. Contemporary with Ford trimotor, it had been in commercial service throughout Central and South America. As a military conversion it has been widely used as troop transport, glider tow, and bomber. Lightly armed with four flexible guns on forward, side, and dorsal positions of fuselage. Featured largely in the Norwegian and Crete campaigns and still used.

Span.....95 ft. 11 in.
Length.....62 ft.
Height.....14 ft. 10 in.
High speed.....189 mph.
Max. range.....1,000 mi.
Gross wt.....23,200 lb.
Power.....three 760-hp. BMW.



British Combine

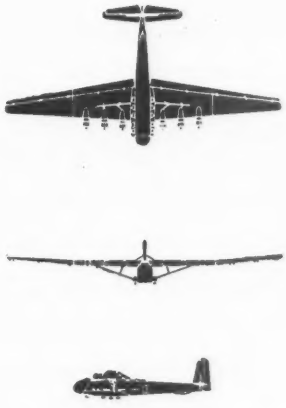
Junkers Ju-90

A development of the little-known Ju-89 as a large 40-passenger troop transport. Though few of these have been seen in service, it is believed they are still in production. Some models are probably equipped for bombing duty. Characteristic swept-back wing is designed with Junkers wing flaps similar to those on Ju-52. Armament is not definitely known but is probably not heavy.

Span.....137 ft. 6 in.
Length.....91 ft. 9 in.
Cruising speed.....185 mph.
High speed.....260 mph.
Max. range.....1,250 mi.
Gross wt.....55,000 lb.
Power.....four 1,600-hp. BMW.

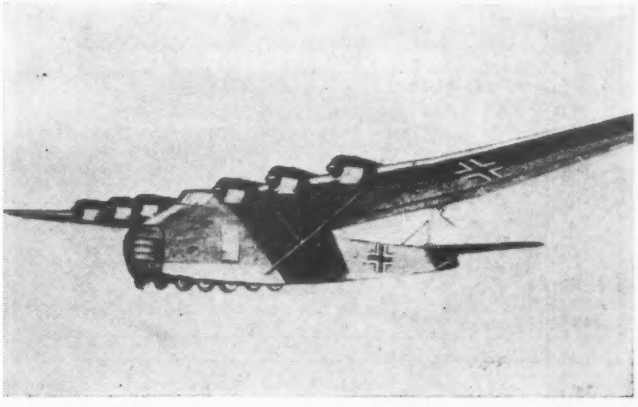
British Combine

Messerschmitt Me-323

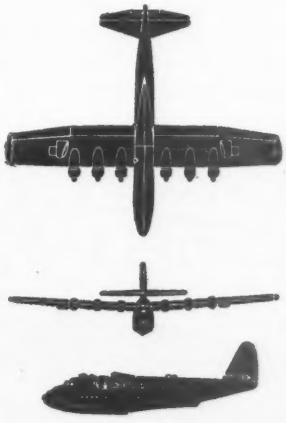


One of the most ungainly monsters yet in the war, this six-engine, 130-passenger troop transport made its unhappy debut in the Tunisian campaign. Thirty-seven of these "box cars" were blown up in mid-air by Allied fighters while attempting to flee Africa with troops. With roll-up snout and multi-wheel landing gear, these slow, "power gliders" handle both tanks and personnel. Disposable load 22,000 lb.

Span.....181 ft.
Length.....93 ft. 4 in.
Height.....24 ft.
High speed.....170 mph.
Max. range.....500 mi.
Gross wt.....65,000 lb.
Power...six 750-hp. Gnome-Rhone



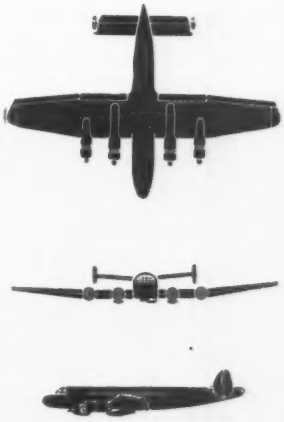
Blohm & Voss BV-222



Ranked with the Focke-Wulf *Kurier* as a possible threat to eastern U. S. cities, this craft appears to be a combination of the Boeing *Clipper* and Short *Sunderland*. Its six engines and two small wing floats are main differences. Armament consists of power turret atop cabin, glass-enclosed gun mount behind rudder, and at least two gun positions on each side of hull. Used extensively against Atlantic convoys as a long-range reconnaissance boat.

Span.....150 ft.
Length.....112 ft.
High speed.....199 mph.
Gross wt.....100,000 lb.
Power.....six 1,000-hp. BMW.

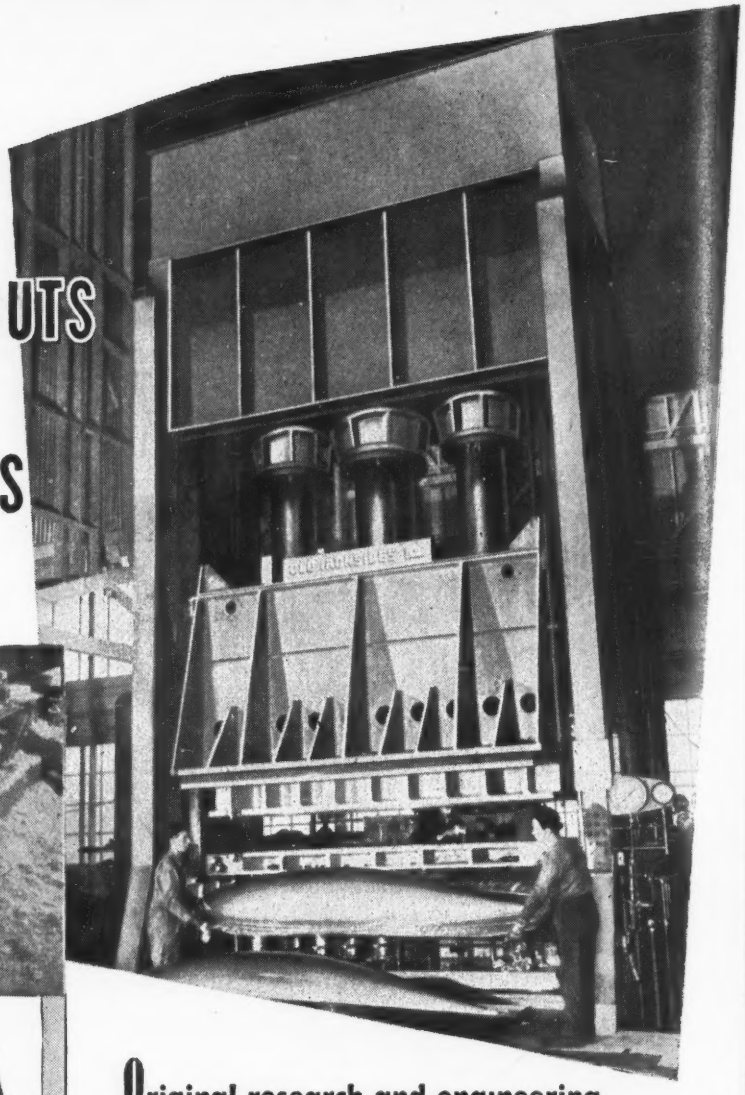
Junkers Ju-290

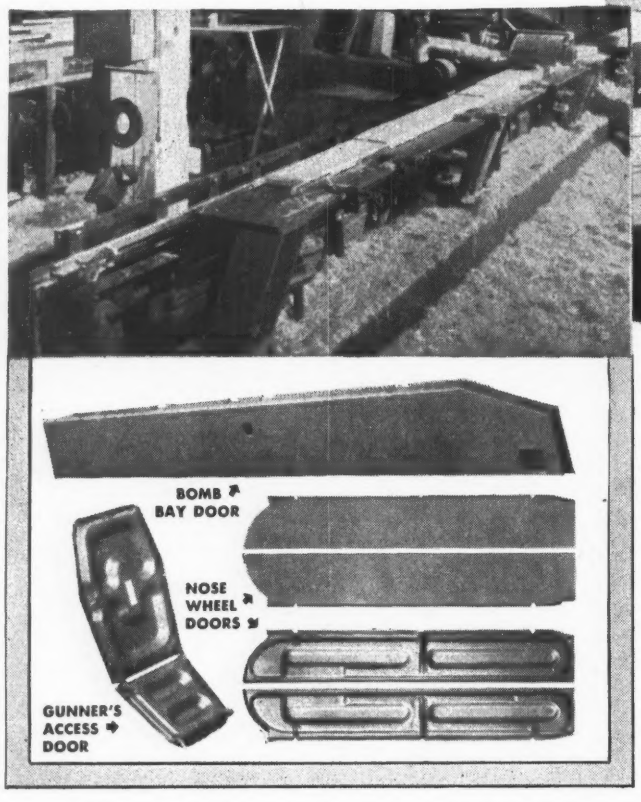


Latest in the Junker series of troop transports, this model, still patently of the same basic design as the Ju-90, has been cleaned up and further streamlined. Notable differences are rectangular wing section with tapering tips. High tail planes and rudder suggest its use as a paratroop plane. Some models equipped with pressure cabins. No data available on armament.

Span.....123 ft.
Length.....86 ft. 3 in.
Height.....21 ft. 3 in.
High speed.....250 mph.
Max. range.....1,491 mi.
Gross wt.....55,000 lb.
Power.four 1,000-hp. Bramo Fafnir

Weber
PRODUCTION SHORT CUTS *speed* AIRCRAFT ASSEMBLIES





PROFILER PLANNER (ABOVE) Another time saving Weber device. Jobs that formerly required 6 hours of hand planning are completed by 6 simple mechanical operations in 40 minutes.

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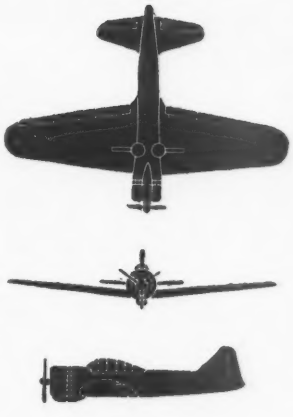
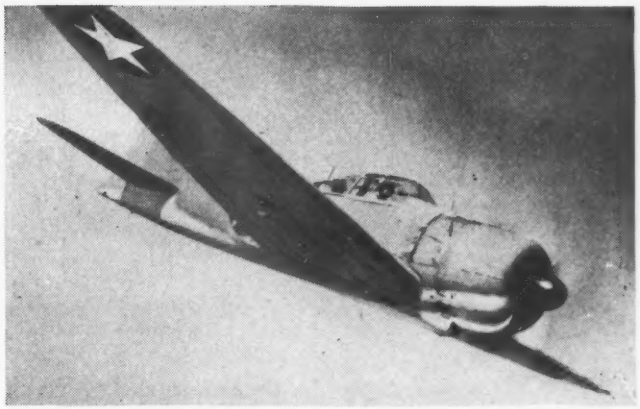
Fighters

Mitsubishi 00 Zeke

Probably the most famous single plane in the entire Jap air force, this single-seat carrier- or land-based fighter has exceptional performance. Trim and lightly built, it is highly maneuverable with exceptional climbing power—approximately 6,000 fpm. U. S. flyers have, however, triumphed over these poorly protected ships. Armament: Two 20-mm. wing cannons, and two 7.7-mm. machine guns in cowl.

Span.....39 ft. 5 in.
Length.....30 ft. 3 in.
Height.....9 ft.
High speed.....328 mph.
Max. range.....1,500 mi.
Gross wt.....5,140 lb.
Power.....one 1,100-hp. Kinsei



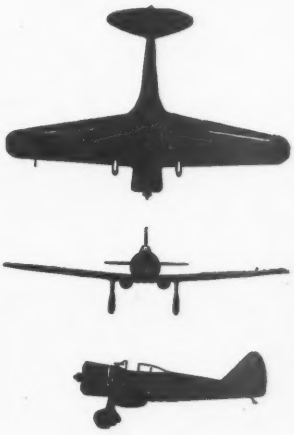


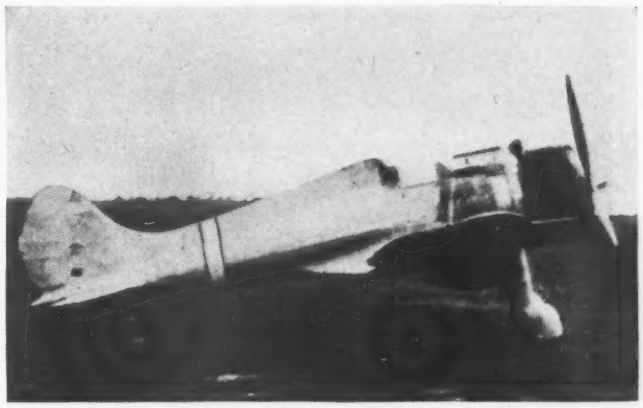
Official U.S. Navy photo

Mitsubishi *Nate*

One of Japan's oldest fighter models, this single-seater, after many changes, set the stage for the famous *Zero*. Originally produced with open cockpit and fixed landing gear as a low level fighter, Nate is now a closed plane with retractable gear. Gas tanks are located in the wing roots, and extra, detachable tanks are accommodated externally. Lacks protective armor and radio. Highly maneuverable, but mounts only two 7.7-mm. machine guns in cowl.

Span.....40 ft.
Length.....25 ft.
High speed.....265 mph.
Max. range.....595 mi.
Gross wt.....4500
Power.....one 650-hp. Nakajima

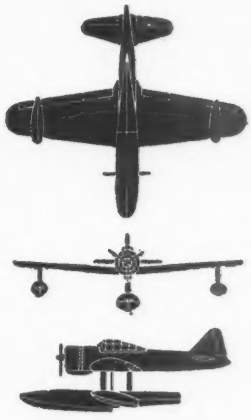




Mitsubishi *Rufe*

Navy float-plane version of the infamous *Zero*. In spite of addition of one central pontoon and two fixed wing floats, it is conceded to be a good performer, though somewhat slower than *Zeke*. Operating from seaplane tenders or island bases in Solomons, it is used mainly for reconnaissance duty. However it works excellently as a defensive fighter. Armament is believed to be same as *Zeke's*.

Span.....39 ft. 5 in.
Length.....34 ft. 6 in.
Height.....14 ft.
High speed.....310 mph.
Gross wt.....6,500 lb.
Power.....one 1,050-hp. Kinsei



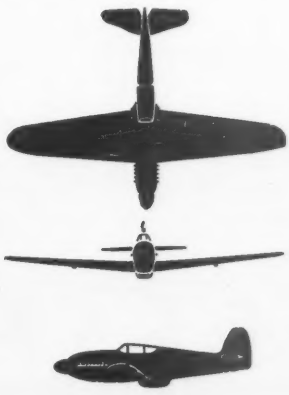
Mitsubishi *Hap*

Sometimes easy to confuse with a Grumman F4F *Wildcat*, this latest model of the *Zero* line has almost everything but pilot armor, fire power, and self-sealing tanks of its American counterpart. Most notable changes in this newest fighter are the square wing tips and a new engine with 100 hp. more than earlier models. All-around performance is better than its fore-runner, *Zeke*, though its armament is probably the same.

Span.....36 ft. 6 in.
Length.....29 ft. 8 in.
High speed.....350 mph.
Gross wt.....5,100 lb.
Power....one 1,200-hp. Nakajima.

Tony

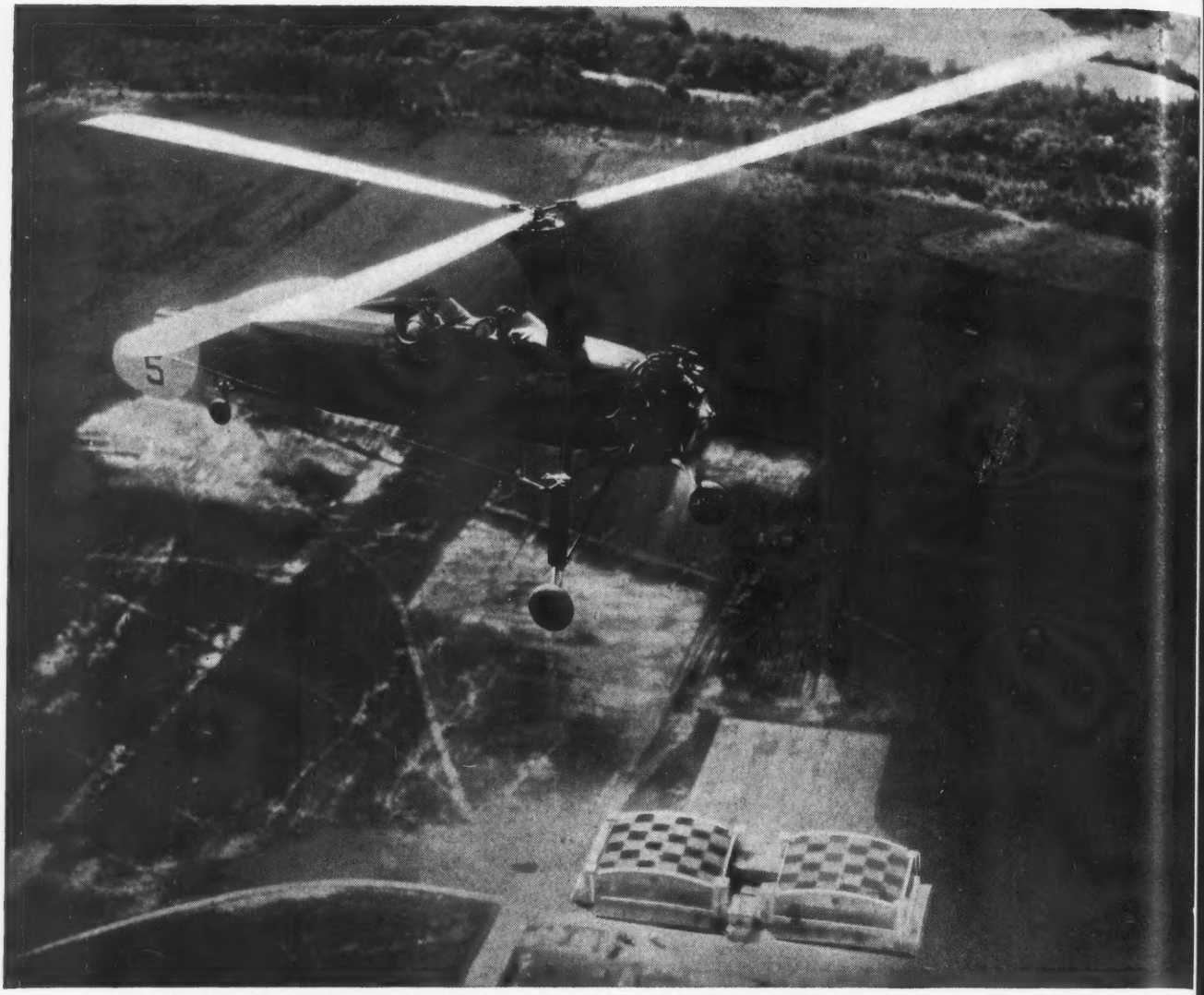
From certain angles apparently very similar to the British Hawker *Hurricane*, this new single-seat fighter is the first Jap plane of this type to have an in-line liquid-cooled engine. Visible bulges on under side of wing suggest two possible uses of plane: It could be a long-range fighter with jettisonable gas tanks or a low level attack bomber carrying light anti-personnel bombs. No information as to performance or armament has yet been made available for publication. This silhouette is provisional and unofficial.



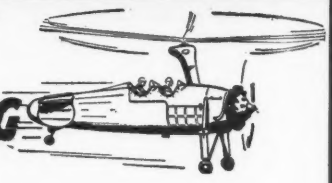
Nakajima Oscar

That the Japanese are now breaking away from their suicide philosophy of aerial warfare is evidenced by the appearance of self-sealing gas tanks in this fighter model. They have not proved effective, however, against .50-cal. bullets. Used widely in Pacific and Asiatic areas against enemy bombers and ground installations, *Oscar* is surprisingly slow but maneuverable. Armed with only two 12.7-mm. machine guns.

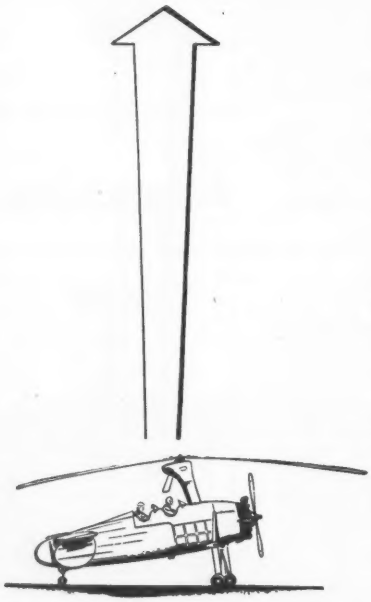
Span.....37 ft. 7 in.
Length.....28 ft. 7 in.
High speed (approx.)...380 mph.
Gross wt.....6,050 lb.
Power.....one 1,050-hp. Kinsei.



One of an earlier fleet of Kelletts, developed in cooperation with the United States Army Air Forces.



15 YEARS OF ROTARY WING PIONEERING



A Kellett takes off vertically, lands practically anywhere. Air speeds—from practically 0 to 120 MPH.

1944 marks the fifteenth year during which Kellett has been producing rotary wing aircraft. Each year the path of progress in this branch of aeronautical science has been extended by additional Kellett in-the-air accomplishments.

All wartime production of Kellett's advanced types of rotary wing ships is in cooperation with the United States Army Air Forces—details may not be given now.

But among many, even *pre*-war indicators of postwar opportunities to save time and cut costs for industry, commerce and agriculture, is this historic Kellett record: completing 2,607 flights in a single year, on a daily timetable, between airport and the Philadelphia post office roof, month after month, in all seasons.

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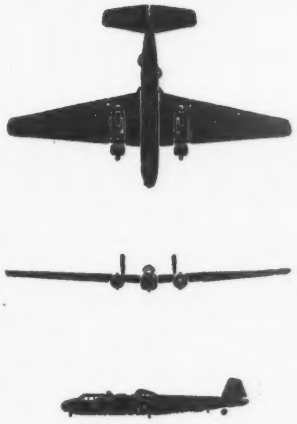
KELLETT

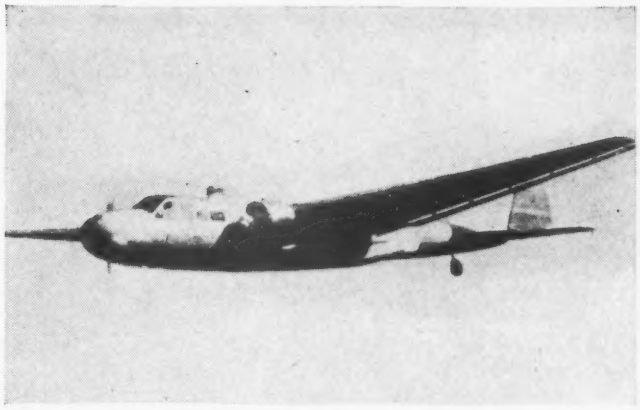
OLDEST ROTARY WING AIRCRAFT MANUFACTURING COMPANY

ombers

Mitsubishi *Nell*

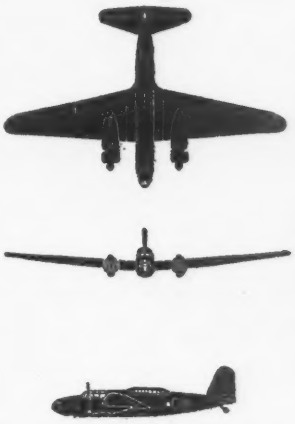


is is one of Japan's best medium mbers. Copied from German nker Ju-86, it has been improved d adapted to Nippon's own bomb- g tactics. Though not of high per- rmance, it can be used for either gh-level bombing or torpedo at- cks. Armament includes five 7.7- m. machine guns and one 20-mm. rret cannon. Carries a crew of ven. Most famous mission of ese craft was sinking of *Repulse* d *Prince of Wales.*

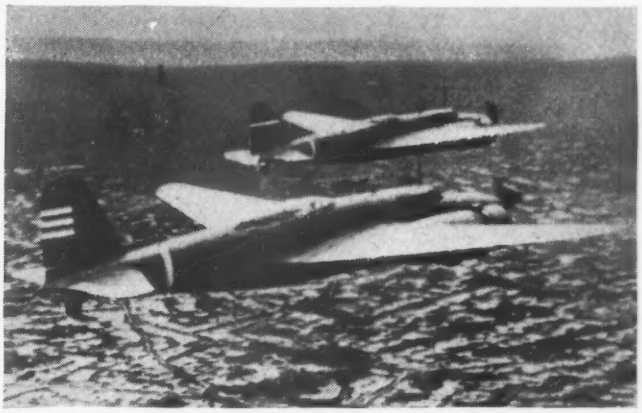


an.....82 ft.
ngth.....54 ft.
eight.....12 ft. 6 in.
gh speed.....230 mph.
x. range.....1,615 mi.
oss wt.....17,570 lb.
wer.....two 1,000-hp. Kinsei

Mitsubishi *Sally*

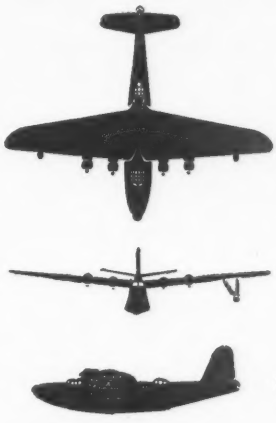


o versions of this model are be- g produced currently. Mark I is e chief operational type, carrying ew of seven and maximum bomb d of 4,400 lb. and mounting ven 7.7-mm. flexible machine ns. Larger Mark II is 40 mph. ster, has about 6,000 ft. addi- nal ceiling, and mounts a 12.7- m. turret gun in rear of green- use, also a stinger in the tail. th marks lack adequate armor.

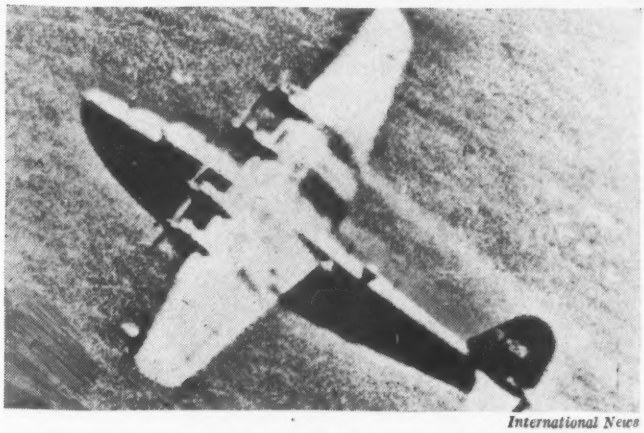


an.....72 ft.
ngth.....52 ft.
eight..... 12 ft.
gh speed (approx.)....260 mph.
x. range.....670 mi.
oss wt. (approx.)....24,000 lb.
wer...two 1,000-hp. Mitsubishi

Emily



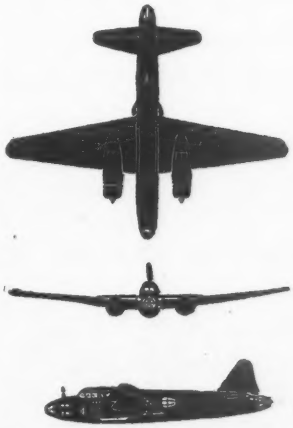
e of largest in the Jap air forces, is four-engine flying boat is be- ved to be a further development standard long-distance patrol ane, the *Mavis.* Though at pres- t only a limited number are in rvice, this new monster has been otted by American flyers on econnaissance over enemy terri- y. It is also believed to have ade several long patrols outside Jap-held areas. Information as specifications and performance e sketchy, but dorsal and tail eas seem to be well guarded by n blisters. Bottom of long, deep ll is stepped for hydroplaning.



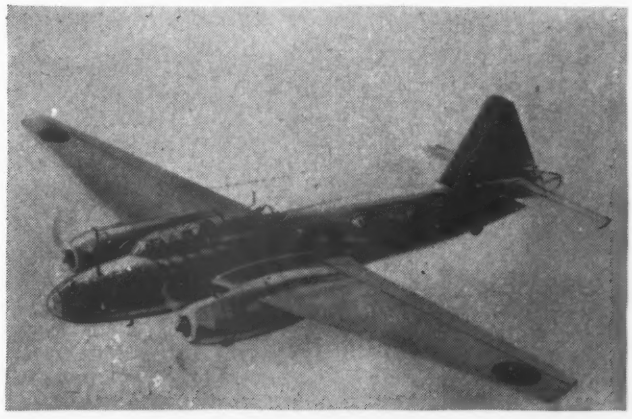
International News

an.....118 ft.
ngth.....91 ft.

Mitsubishi *Betty*



is newest medium bomber now service is further proof that ps no longer think planes and en are expendable, for both armor d armament are heavier. At st six 7.7-mm. machine guns istle from nose, top, and two side isters with a 20-mm. cannon ount in tail. Self-sealing gas nks have also been used, but are t very effective. With a crew of ven, it carries a bomb load of 00 lb. or two torpedos.



an.....76 ft.
ngth.....64 ft.
eight.....18 ft.
gh speed (approx.)....270 mph.
x. range (approx.)..2,000 mi.
oss wt. (approx.)....26,000 lb.
wer.....two 1,050-hp. Kinsei

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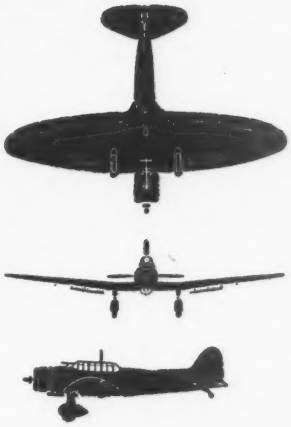
Japanese

Aichi 99 *Val*

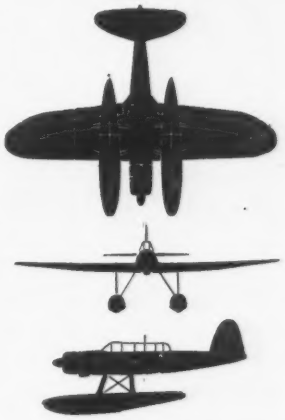
Backbone of the dive bomber force used in the Pearl Harbor attack, this two-place dive bomber appears to be a typical adaptation of foreign designs. It has fixed landing gear and dihedral of the Nazi *Stuka* and fuselage shape of U. S. Navy planes. Lightly constructed and poorly armed, it is, nevertheless, effectively used in shallow dives up to 340 mph. Maximum diving angle is reported to be about 70 deg.

Span.....48 ft.
Length.....35 ft.
High speed.....236 ft.
Max. range.....600 mi.
Gross wt.....5,270 lb.
Power.....one 900-hp. Kinsei



Aichi 00 *Jake*

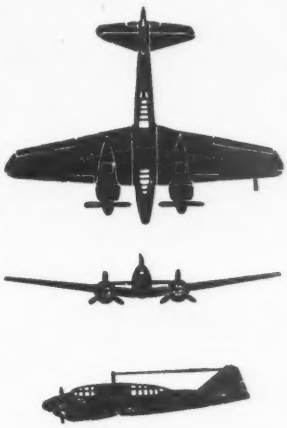
Originally believed to have been float-plane conversion of Type 99 dive bomber *Val*. Recent reports, however, prove this supposition wrong. Similarity between two planes is quite striking. Both have elliptical wings, but tail groups are different. *Jake* has a conventional elliptically-shaped rudder; *Val* carries a rather large vertical fin which extends forward as a long, low fin fairing into fuselage. As is characteristic of Jap float planes, *Jake* serves a dual role as dive bomber and short-range reconnaissance plane. Though a fairly recent model, it is pitifully underarmed, having but one 7.7-mm. gun in rear cockpit. Carries four 132-lb. bombs.



Dinah

As is the case with most new enemy planes, little is known about the latest Jap models now in service. Apparently, this plane is used as a two-place reconnaissance bomber but can be quickly transformed into a fast fighter if necessary. Its two 14-cylinder air-cooled radial engines give it fair performance — good speed at high altitude and a fast climb of approximately 3,500 fpm. With the exception of its single fin and rudder, it closely resembles German Me-110. Armament probably consists of one 20-mm. cannon and two 7.7-mm. machine guns in nose, two more guns in cockpit.

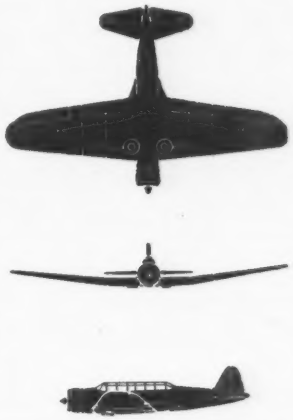
High speed.....324 mph.
Power.....two 1,060-hp. engines.



Nakajima *Kate*

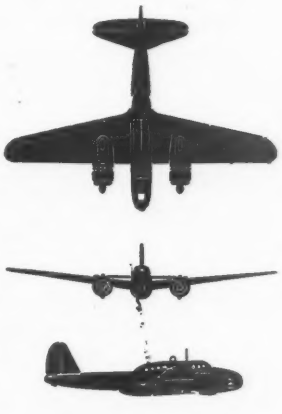
This two-seat attack bomber has been bitter proof to Allied navies that Japanese are experts in the art of torpedo attack. Closely resembling U. S. Navy's TBD *Devastator*, which it apparently copies, *Kate* has paid off well—as the Pearl Harbor wreckage showed. Operating exclusively from carriers, it can be converted for other bombing operations. Armament: Two 7.7-mm. guns in cowl, one in cockpit.

Span.....52 ft.
Length.....34 ft.
Height.....10 ft.
Max. range.....495 mi.
Power.....one 700-hp. Hikari.



Lily

Although this plane is known to have been in production for some time, it has only recently been seen in bombing operations over China and Burma. Similarity between *Lily* and U. S. Martin A-30 *Baltimore* suggests that Japs once again have neatly tailored foreign designs to their own advantage. Noticeable differences between the two planes are small underslung engine nacelles of *Lily* and large centrally-mounted ones of *Baltimore*, also round fuselage shape of former and deep, narrow cross section of latter. Primarily a three-place reconnaissance bomber, *Lily* carries a 1,500 lb. bomb load with nose, dorsal, and belly guns.



Kawanishi *Mavis*

One of most widely used bomber-reconnaissance planes in Pacific, this four-engined goliath can fly over 5,000 mi. with auxiliary fuel tanks. Normally, it carries a bomb load of 3,300 lb. with a crew complement of eight. On certain occasions it has even been used as a torpedo bomber with two 1,760-lb. missiles. Armament consists of four 7.7-mm. guns in nose, dorsal, and side turrets, one 20-mm. tail cannon.

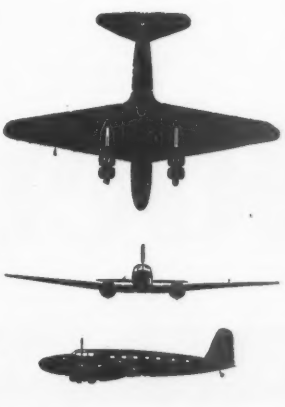
Span.....131 ft.
Length.....82 ft.
Height.....20 ft. 6 in.
High speed.....190 mph.
Max. range.....1,750 mi.
Gross wt.....44,092 lb.
Power.....four 900-hp. Kinsei

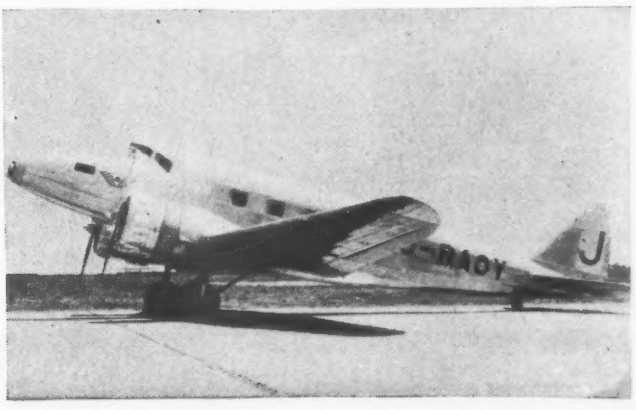
Cargo Transport

Mitsubishi *Topsy*

Army's transport version of the civil airliner, MC-20, shown in the accompanying photograph, has been specially equipped to handle paratroops. Peacetime model is very similar to the early Douglas DC-2. Originally, the MC-20 carried eleven passengers, but the military version probably carries more troops. No armament or protective armor has been used in the conversion. Has retractable landing gear.

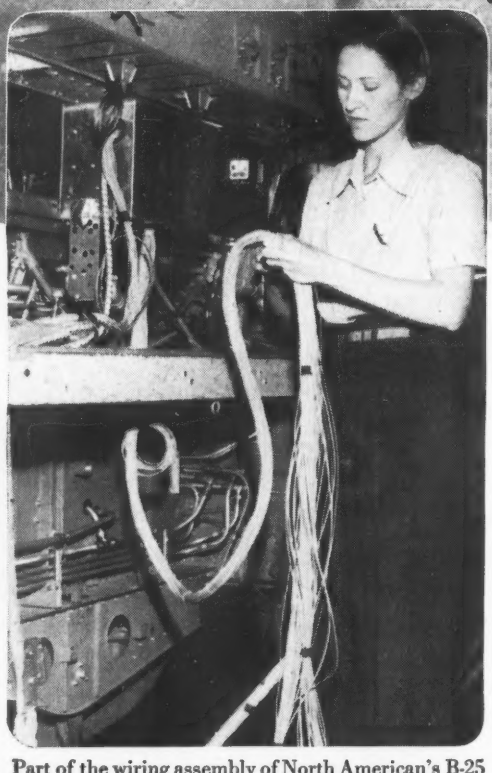
Span.....74 ft.
Length.....52 ft. 9 in.
Height.....16 ft. 2 in.
High speed.....266 mph.
Max. range.....1,240 mi.
Gross wt.....18,300 lb.
Power....two 520-hp. Mitsubishi.





Maker of Air History—

The North American B-25



Part of the wiring assembly of North American's B-25 Mitchell Bomber.

ANOTHER PLACE

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These swift, deadly B-25 Mitchell Bombers, built by North American, are active above all the world's major battle fronts. The fourteen-ton giants have unloaded bombs on the enemy from Tokyo to Tobruk —from Russia to New Guinea.

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Belden Manufacturing Company
4665 W. Van Buren St., Chicago, Ill.

Wiring the pilot's switch box. Altogether, miles of wire are used on the B-25.

Awarded the U.S. Treasury Special Citation of Merit for initiating the War Bond-or-Cash Dividend Plan

Belden *Aircraft* WIRE

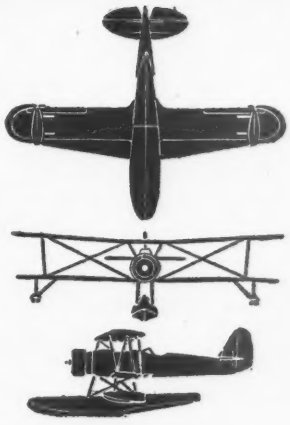
Starter, Lighting, and Instrument Cables √ √ √ SPARK PLUG WIRES

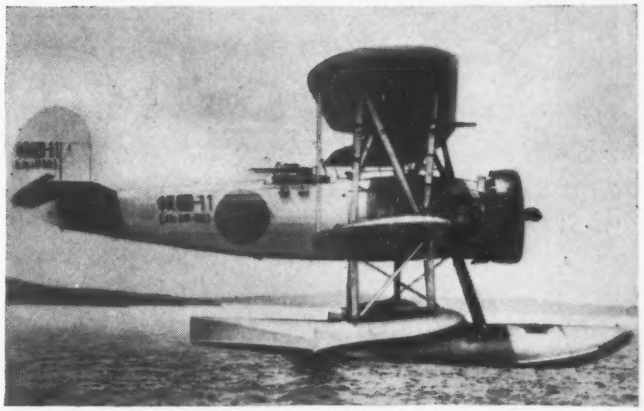
Japanese

Nakajima *Dave*

Photograph shows the prototype of this two-place reconnaissance float plane which has made an excellent record in the Southwest Pacific. As one of the strategic units of the Jap's highly efficient patrol system, fleets of these planes are used to stalk lone ships, maintaining a continuous report on positions until bombers can arrive. Although *Dave* is becoming obsolete, it is still highly effective as a dive bomber. Normal bomb load is 500 lb. Armament is poor: Two 7.7-mm. machine guns, one fixed in cowl, one flexible in cockpit.

Span.....36 ft. 2 in.
Length.....27 ft. 11 in.
Height.....13 ft. 2 in.

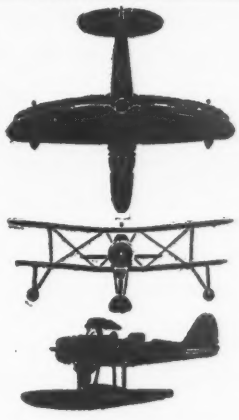




Sasebo *Pete*

One of Jap's new reconnaissance seaplanes, *Pete* is apparently an improved version of its fore-runner, *Dave*. Elimination of some external struts and a general cleaning up of old design with addition of elliptical wings have greatly improved performance of this plane. *Pete* is about 50 mph. faster and has more than double climbing speed of *Dave*. Although, both have same range, *Pete* has a greater service ceiling—30,000 ft. No self-sealing gas tanks. Armed with two 7.7-mm. guns in cowl and one in rear cockpit. Bomb load is 500 lb.

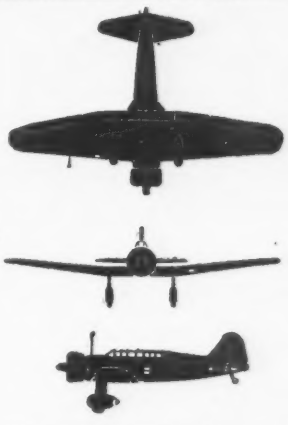
Span.....37 ft.
Length.....26 ft. 6 in.
Height.....12 ft. 6 in.



Mitsubishi *Karigane*

Latest model of a two-place, scout bomber series which has performed well but not brilliantly. Of sound structural design, it is still rather clumsy looking and slow. Probably armed with two 7.7-mm. machine guns in the cowl, it has proved effective against weak defences. The *Karigane I*, an earlier model, in 1937 flew from Tokyo to London in 94¼ hr., a distance of 9,900 mi.

Span.....39 ft. 4 in.
Length.....27 ft. 11 in.
Height.....11 ft. 6 in.
High speed.....310 mph.
Max. range.....1,490 mi.
Gross wt.....5,060 lb.
Power.....one 800-hp. Kinsei



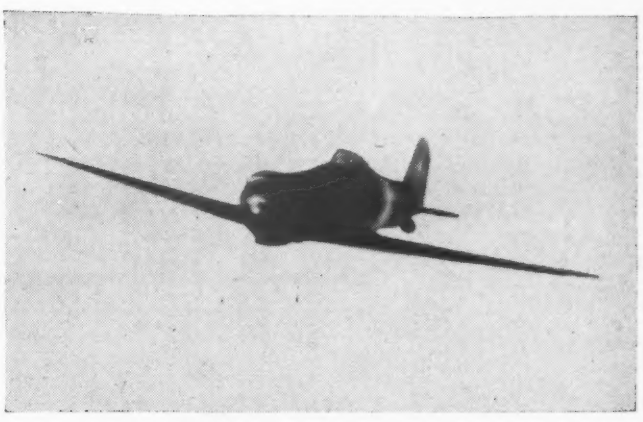
Italian

Fighters

Macchi 200

Though the Italians are best known for their seaplane developments, they have produced during the war several worthy Army fighters. Representing one of the earlier attempts to compete with foreign single-seat, high-performance interceptors, this plane, however, fell short of the mark. Sturdily built, it is slow, though maneuverable. Armament: Two 12.7-mm. machine guns in cowl and two 7.7-mm. guns in wings.

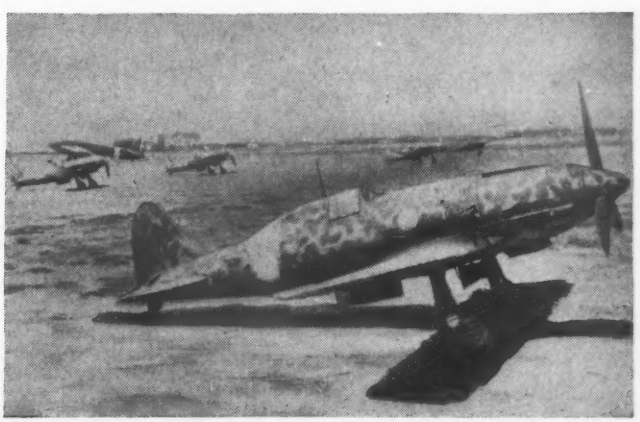
Span.....34 ft. 8 in.
Length.....26 ft. 9 in.
High speed.....314 mph.
Max. range.....435 mi.
Gross wt.....4,840 lb.
Power.....one 840-hp. Fiat



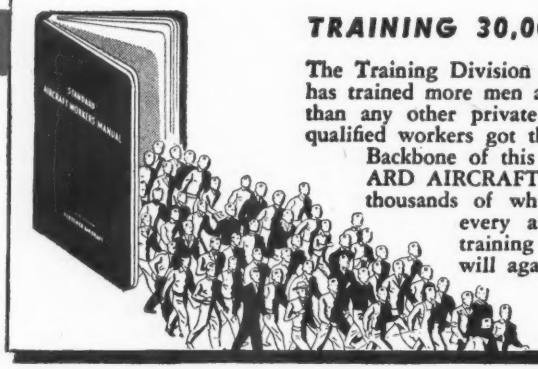
Macchi 202

This single-place fighter seems to be a successful conversion of its predecessor, Macchi 200, from a radial to an in-line engine plane. Use of the German Mercedes-Benz DB-601 power plant of 1,200 hp. has transformed the original, ugly design into a well-trimmed, high performance fighter model. Armament, consisting of two 12-mm. machine guns, is concentrated in the cowl.

Span.....35 ft.
Length.....29 ft. 1 in.
High speed.....350 mph.
Max. range.....460 mi.
Gross wt.....6,300 lb.
Power.....one 1,200-hp. Mercedes-Benz.

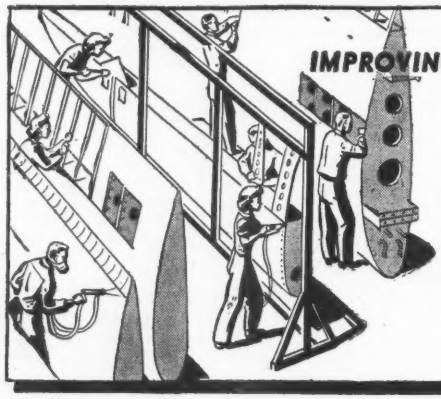


2 LOGICAL STEPS TO *BETTER* POST WAR SERVICE BY *Fletcher*



TRAINING 30,000 MEN AND WOMEN

The Training Division of Fletcher Aircraft undoubtedly has trained more men and women in aircraft fabrication than any other private organization. More than 30,000 qualified workers got their start in aviation at Fletcher. Backbone of this training is the famous STANDARD AIRCRAFT WORKERS' MANUAL, tens of thousands of which are being used in virtually every aviation plant today. This mass training experience now serving the war will again go to work after Victory . . .



IMPROVING RECONSTRUCTION METHODS

Military contracts awarded Fletcher for the reconstruction of battle-damaged airplane assemblies have resulted in the development of new methods that are putting this equipment back in service ahead of schedule. Fletcher has beaten delivery dates on each new contract by adopting volume production techniques in this kind of work. This war experience also will find new usefulness after Victory . . .

BUILDING FOR A NEW KIND OF AIRCRAFT SERVICE

This unique experience with men and methods has provided Fletcher Aircraft with the two vital factors on which to build a *better* post war aircraft and aviation service business. Across America and around the globe Fletcher men and Fletcher methods will offer aviation—after Victory—a new kind of service for "Putting wings on the world."

Fletcher Aircraft BURBANK, CALIFORNIA

Reggiane 2000

The Reggiane company has done well in producing this single-place pursuit plane after having remained inactive since the end of World War I. In the same performance class as the Macchi fighters, it is stubbier with its elleptical wings and round, deep fuselage. Resembles American-built P-43 *Lancer*. It has rearward retractible landing gear and steerable tail wheel.

Span.....36 ft. 9 in.
Length.....25 ft. 9 in.
Height.....12 ft.
High speed.....329 mph.
Max. range.....620 mi.
Gross wt.....5,700 lb.
Power.....one 1,000-hp. Piaggio.

Reggiane 2001

As in the case of the Macchi fighter development, this plane is a modification of the basic Reggiane 2000 pattern for the accommodation of the German in-line Mercedes-Benz DB-601 engine. Reason for change is probably need for more power or production expediency. As in most Italian pursuit planes, armament is poor, consisting only of two large-bore guns in wings.

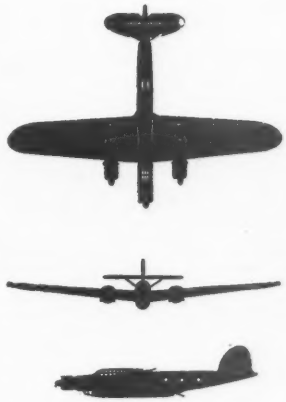
Span.....36 ft. 9 in.
Length.....29 ft. 3 in.
Height.....7 ft. 6 in.
High speed.....360 mph.
Gross wt.....7,600 lb.
Power.....one 1,150-hp. Mercedes-Benz DB-601.

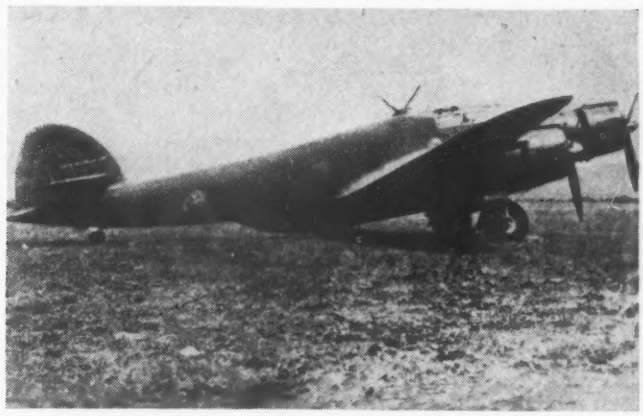
Bombers

Cant. Z-1007bis

True of many Italian aircraft, this three-engine, heavy bomber is becoming rapidly outmoded. Armament: One 12.7-mm. machine gun in dorsal turret and one in the belly, and two 7.7-mm. guns on lateral mountings. Carrying a pay load of only 2,600 lb., this attacker did not prove difficult for Allied interceptors. Lack of strategic metals has produced ingenious all-wood construction.

Span .....81 ft. 4 in.
Length .....60 ft. 4 in.
Height .....17 ft.
High speed .....280 mph.
Max. range .....930 mi.
Gross wt. .....28,260 lb.
Power.....three 1,000-hp. Piaggio.

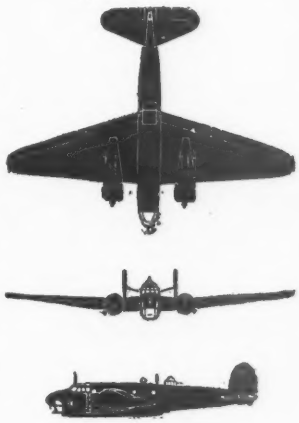


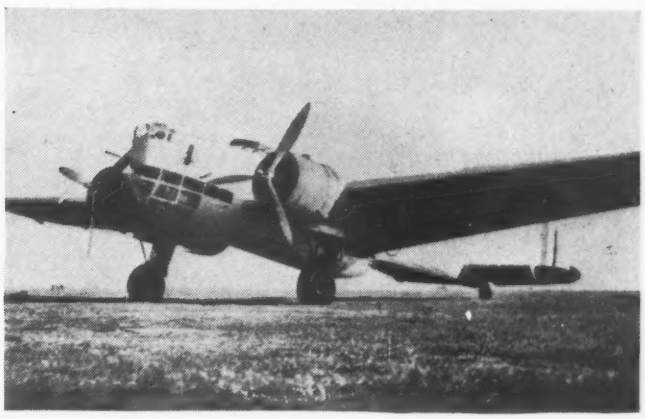


Fiat BR-20M

A notable departure from the traditional three-engine Italian bombers, this twin-engine medium-weight is one of the few of clean streamlined jobs. Performance, however, is not as good as other contemporary models. Armament is light: One 12.7-mm. gun in retractable power-turret amidships, and two 7.5-mm. Breda machine guns placed in nose and underneath the fuselage. Service ceiling about 36,000 ft.

Span .....70 ft. 6 in.
Height .....52 ft. 10 in.
Length .....14 ft. 1 in.
High speed.....268 mph.
Max. range.....1,863 mi.
Gross wt.....22,220 lb.
Power.....two 1,000-hp. Fiat.

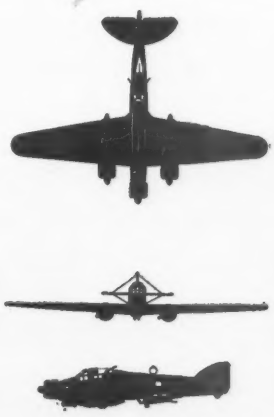




Savoia-Marchetti SM-79

Another heavy bomber whose performance is fair despite fact it is underpowered. Pay load is barely 2,200 lb. of bombs. Pilot and bombardier's quarters are lined with protective armor. Prominent belly blister aft of bomb bay is the bomber's position. Armament consists of four machine guns, one on fixed forward mount, two on movable mounts above and below fuselage aft of wings, and one as tail stinger.

Span .....66 ft. 3 in.
Length .....53 ft. 2 in.
Height .....13 ft. 6 in.
High speed .....294 mph.
Max. range .....1,240 mi.
Gross wt. .....24,860 lb.
Power.....three 1,000-hp. Piaggio.



International News

First Choice for Tough Assignments

Ahlin Kingston and Ted Weiss of Republic's Engineering Dept. shown selecting Klixon Protectors for their electric circuits.

KLIXON AIRCRAFT CIRCUIT BREAKERS

Designed to fight up where it's cold . . . Republic P-47 Thunderbolts protect Fortresses as they wing over the Channel to rain death on the enemy.

To get the most out of the electrical circuits of these high altitude P-47 fighters, Klixon circuit breakers and protectors are used. Why? Because these compact, light-weight protectors are built to take it under all flying and fighting conditions. They are unaffected by shock, vibration, motion . . . regardless of the position of mounting . . . and they operate positively and precisely in all ranges of altitude, protecting circuits from serious damage caused by shorts and overloads. No wonder Klixon Aircraft Circuit Breakers . . . switch and push button types, indicating and non-indicating, remotes and automatics and others . . . are first choice for all types of aircraft.

Send for complete bulletins. They show sizes, weights and performance characteristics of Klixon Protectors.

KLIXON

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Rotary Wing Aircraft—Gliders

Sikorsky YR-4

st helicopter to be ordered by Army, this model is being anufactured both by Sikorsky v. of United Aircraft Corp. and, der license, by Nash Kelvinator. represents the culmination of rs of experimental and develop- nt work on the part of famed signer Igor Sikorsky. Both main anti-torque rotors have three des.

gth .....31 ft. 6 in.
tor blade dia.....38 ft.
ti-torque rotor diam...7 ft. 8 in.
ti-torque rotor diam...7 ft. 8 in.
ss wt.....2,530 lb.
t. empty.....2,011 lb.
nding gear tread.....10 ft.
wer.....one 180-hp. Warner

PV-2

veloped by the P-V Engineering rum, this single-place 'copter de its first public flight late last ar. Fuselage is conventional lded tube truss construction, ric-covered. Three-blade main tor has steel tube spar, and oden ribs, leading and trailing ge, all fabric covered.

tor blade dia.....25 ft.
tor blade chord.....9½ in.
tor blade speed (cruising) 350 rpm.
ti-torque rotor dia.....5 ft.
ti-torque rotor speed (cruising)..1,600 rpm.
gh speed.....90-100 mph.
uising speed.....65 mph.
wer.....one 90-hp. Franklin.

Kellett YG-1 Autogiro

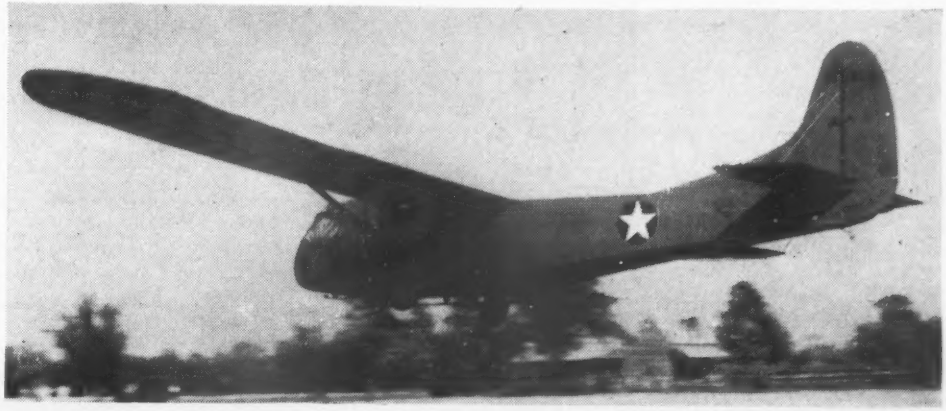
is military model, developed om commercial types, was pur- ased by the Army to be utilized a ground force cooperation craft reconnaissance, artillery obser- tion, and personnel carrying rk, especially in rugged and re- icted terrain where its ability land in very small spaces gives performance impossible with ed-wing aircraft. Rotor blades, hich have a diameter of 40 ft., n be folded back, fitting into cks provided for the stabilizer.

tor blade dia.....40 ft.
ngth (with blades folded) 25 ft. 10½ in.
eight .....10 ft. 9⅞ in.
nding gear tread....9 ft. 6½ in.
wer.....one 7-cyl. Jacobs.

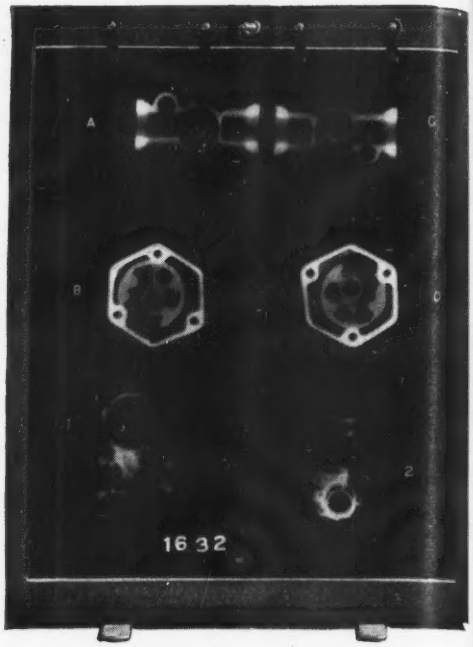
Waco CG-4A Troop Carrier

e Army's standard troop-carry- g glider, this Waco-designed craft now also being built by eight her producers. With a crew of o, it carries 13 fully equipped oops or a smaller number with jeep, small cannon, or other uipment.

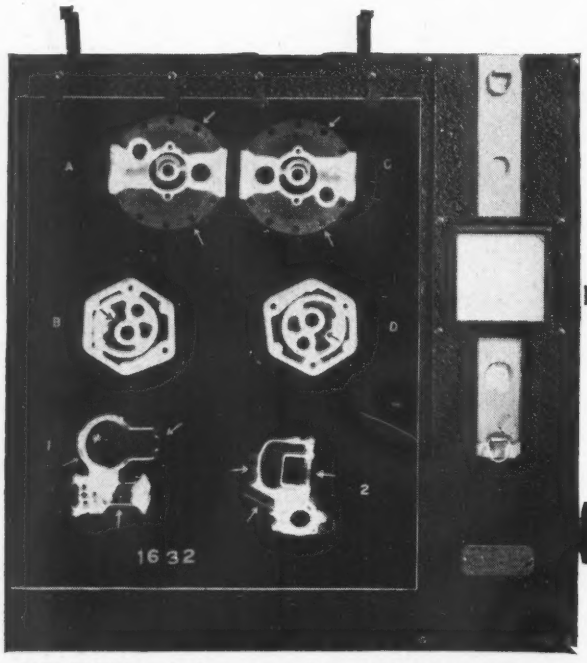
an .....83 ft. 8 in.
ngth .....48 ft. 2 3/16 in.
eight .....11 ft. 7½ in.
ing area.....851.5 sq.ft.
leron area.....42.7 sq. ft.
in area.....39.35 sq. ft.
udder area.....33.57 sq. ft.
abilizer area.....59.4 sq. ft.
levator area.....54.4 sq. ft.



What's Wrong WITH THIS RADIOGRAPH?



Not a thing in the world. It's the illuminator that's at fault. An ordinary, run-of-mine illuminator that allows vital detail to remain unseen. And that may permit serious flaws to escape notice. The usual illuminator is seldom adequate for film of more than 1.5 density.



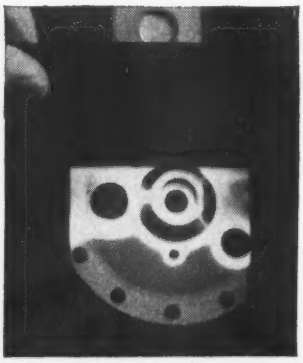
KELEKET *High Intensity* ILLUMINATOR

What's Right WITH THIS ONE?

IT'S *all* right—and, believe it or not, it's the *same* film as above! But viewed this time on the KELEKET High Intensity Illuminator—with every square inch of a 14" x 17" surface brilliantly lighted! Now every detail is clearly evident. Now no flaw can escape the inspector's eye. And film up to 4.0 density and beyond may be used, with marked improvement in radiographic contrast. For viewing films of varying densities, a stepless voltage control gives optimum illumination for each density. For information on the KELEKET High Intensity Illuminator, see your nearest KELEKET representative or write for Catalog F-11.

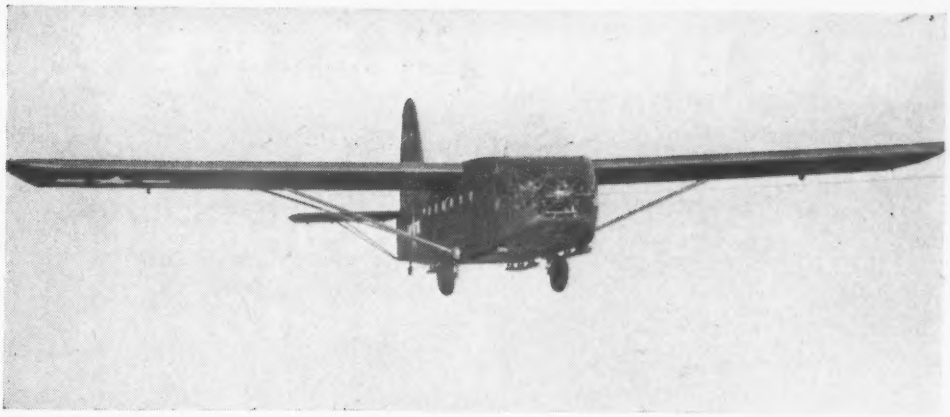
In the Spotlight!
ILLUMINATION Multiplied by Four!

Are there suspicious areas on your radiographs? Then illuminate them with the 3" spot on the KELEKET High Intensity Illuminator. Four times the illumination of the larger surface etches the smallest detail in sharp relief!



KELLEY-KOETT X-RAY MFG. COMPANY
2402 WEST FOURTH ST., COVINGTON, KY.

PIONEER CREATORS OF QUALITY X-RAY EQUIPMENT SINCE 1900



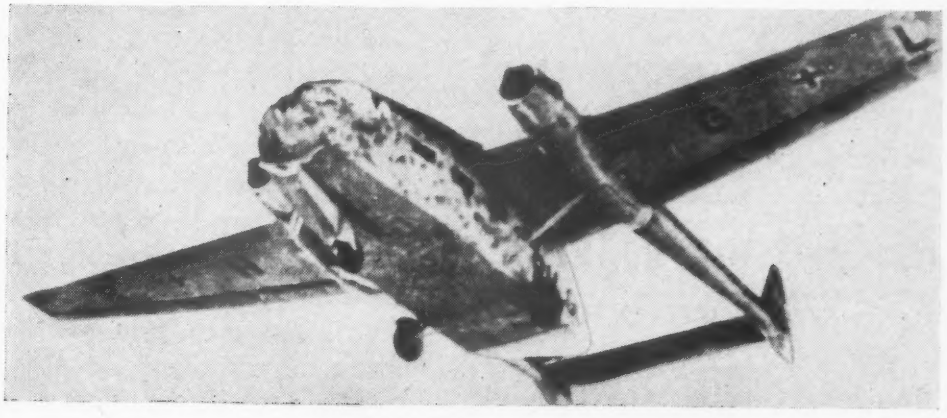
Waco CG-13

Newest Waco glider design, being manufactured by Ford Motor Co., and Northwestern Aeronautical Corp. All data on size, weight and performance are restricted; only information which the Army has permitted to be released is fact that CG-13 carries 30 men, more than twice the load of the CG-4A.

Airspeed *Horsa*

With a crew of two, this largest of British troop carriers has a normal capacity of 20 troops, but can accommodate up to 25. Wing is of wood construction with wood leading edge and fabric covering from front spar to trailing edge, and fuselage is plywood covering over wood bulkheads and stringers. Both flaps and brakes are provided, the latter being grid type flush with the wing when not in use. The *Horsa* is equipped with tricycle landing gear which may be dropped, landing then being effected on single skid beneath fuselage.

Span.....88 ft.
Length.....67 ft.
Wing area.....1,104 sq.ft.
Gross wt.....15,250 lb.



Gotha Go-242

A twin-boom transport glider with a capacity of crew of two and 21 troops, or approximately two tons of cargo. Widely used by Nazis in African campaign. Although originally designed as a straight glider —usually towed by the Ju-52— later models, such as that illustrated, have small power plants set ahead of the booms both to assist on takeoff and to stretch gliding angle. Equipped with tricycle landing gear. Loading and unloading is through wide door set in aft end of fuselage.

Span.....79 ft.
Length.....52 ft. 6 in.
Gross wt.....8,500 lb.
Wt. empty.....3,200 lb.

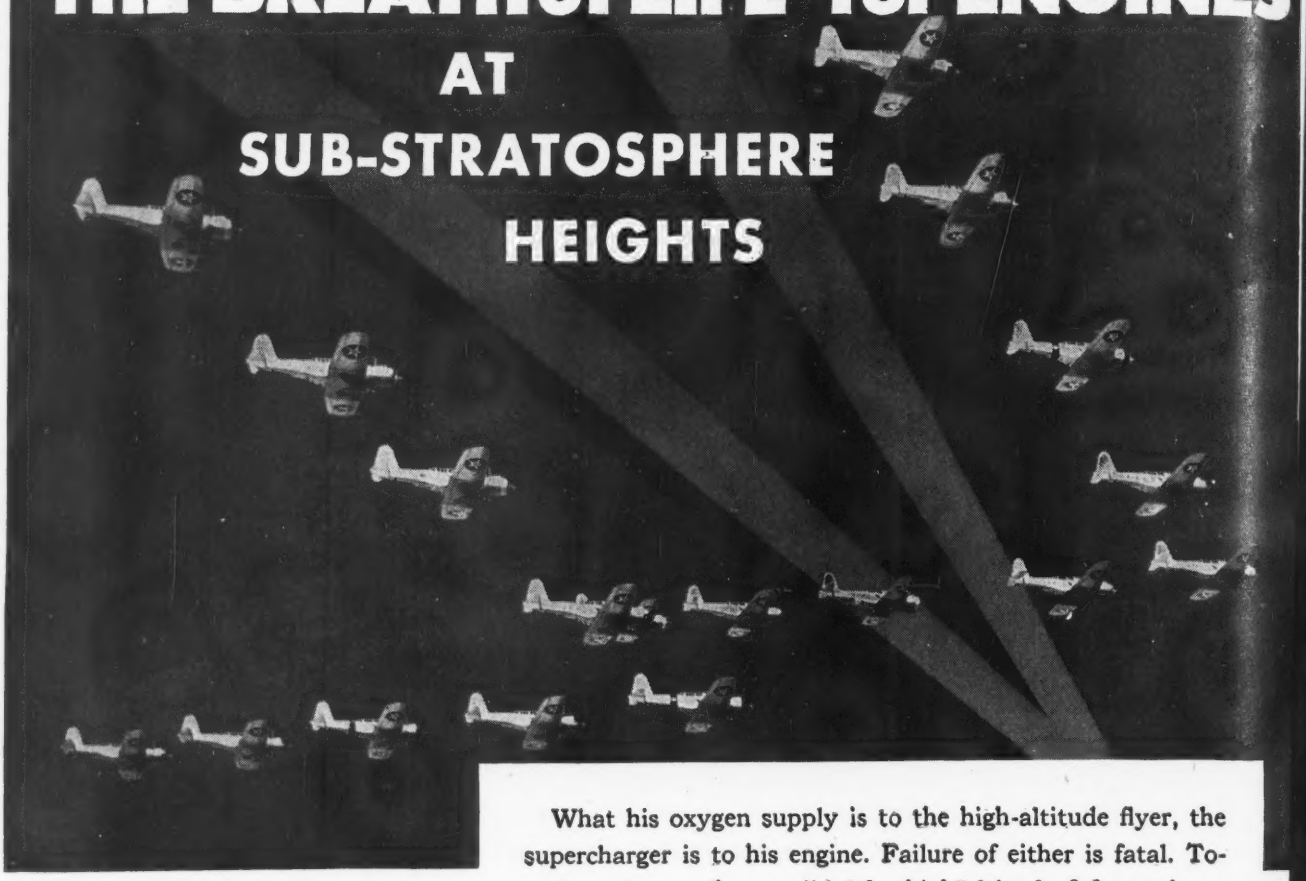
DFS-230

Reportedly designed by Hans Jakobs, who is also credited with the Gotha 242, the DFS-230 carries a pilot and 10 troops, the latter seated in tandem, straddling a bench set in the middle of the fuselage. First used in the invasion of Crete, this model was also found on fields abandoned by Nazis as they retreated across Africa. Fuselage is of conventional welded tubular construction, fabric covered.

Span.....69 ft. 11 in.
Length.....37 ft.
Gross wt.....4,500 lb.
Wt. empty.....1,700 lb.

Norma-Hoffmann Precision Bearings Help Supply

"THE BREATH of LIFE" for ENGINES AT SUB-STRATOSPHERE HEIGHTS



What his oxygen supply is to the high-altitude flyer, the supercharger is to his engine. Failure of either is fatal. Together, they make possible the high-altitude fighter planes and bombers that are playing so conspicuous a part in today's warfare.

In the use of anti-friction bearings in superchargers, as in so many other aviation applications, NORMA-HOFFMANN pioneered the way. The terrific speeds of supercharger operation —often as high as 60,000 RPM—demand that ULTRA-PRECISION long characteristic of NORMA-HOFFMANN BEARINGS. And today, not only in superchargers but elsewhere at vital points throughout the plane, NORMA-HOFFMANN PRECISION BEARINGS are doing their part in winning air supremacy for the Allied Air Forces in every theatre of war.

"Where the bearings MUST NOT fail"—in engines, control mechanisms, instruments, armament, radio equipment and other aircraft accessories—they are providing that combination of speedability, load capacity and dependability so vital to the unfailing performance of the plane.

Let our engineers work with you.

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PRECISION BEARINGS

BALL, ROLLER AND THRUST

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"Pioneer Suppliers for 20 Years of Ultra-Precision Bearings for Superchargers"

TO WIN THE WAR—*Work—Fight—Buy War Bonds!*

Aviation's American Aircraft Speci

Manufacturer	Designation or Model No. Army	Designation or Model No. Company	A.T.C. number	Type	Number of seats	Power Plant: Make of engine	Power Plant: Total rated hp. each	Power Plant: At altitude, ft.	Power Plant: Fuel capacity, gal.	Power Plant: Normal range, mi.	Power Plant: Propeller diameter, in	Performance: High speed, mph.	Performance: At altitude, ft.	Performance: Cruising speed, mph.	Performance: At altitude, ft.	Performance: Stalling speed, mph.	Performance: Climb at sea level, ft. per min.	Performance: Service ceiling	Weights: Wing loading (lb. per sq. ft.)	Weights: Power loading (lb. per hp.)	Weights: Weight empty	Weights: Gross weight, lb.	Dimensions: Span	Dimensions: Length overall	Dimensions: Height overall	Areas (Sq. Ft.): Wing (including ailerons)	Areas (Sq. Ft.): Ailerons (total)	Areas (Sq. Ft.): Fin
onca Aircraft Corp.	L-3B			CML	2	1 Con	65	SL	12	218	72	87	SL	79	SL	46	404	10,000	7.69	20	870	1,300	35′	21′ 10″	9′ 1″	169	15.52	5.51
lover Kent Aviation Corp.		Langley	755	CML	4	2 Franklin	90	SL	35	350	60	138	SL	117	SL	60	695	13,300	15.45	14.70	1,738	2,650	35′	20′ 10″	7′ 1″	171.5	16.66	4.48
egate Amphibians, Inc.		A.D.-1		CMF	2	1 Franklin	135	SL		450	76	125	SL	108	SL	48	580	14,000	10.9	16	998	1,850	34′	24′ 4″	7′ 10″	170	18.80	10.2
h Aircraft Corp.	AT-7(SNB-2)			CML	5–6	2 P&W	450	SL	206	735	99	223.5	5,000	194	5,000	61	1,660	24,000	22.5	8.7	5,815	7,850	47′ 8″	34′ 3″	9′ 4″	349	22.8	16.3
	AT-10[1]			CML	2	2 Ly	295	SL	128	765	99	200	SL	176	SL	64	1,150	19,800	20.1	10.15	4,749	6,000	44′	32′ 2″	10′ 4″	298	20.8	15.2
	AT-11(SNB-1)			CML	4–5	2 P&W	450	SL	128	565	99	216	5,000	192	5,000	65	1,125	20,000	25	9.7	6,158	8,727	47′ 8″	34′ 2″	9′ 8″	349	22.8	16.3
	C-43(GB-2)			CBL	5	1 P&W	450	SL	66	525	99	203	5,000	171	5,000	50	1,500	24,300	14.3	9.45	3,085	4,250	32′	26′ 1″	8′	296.4	22.96	6.5
Aircraft Corp. †	P-39	26		CML	1	1 Allison	1150	12,000	104		124.5	380+						35000+	35.5	6.58	5,523	7,496	34′	30′ 2″	9′ 3″	213.2	15.46	7.9
ng Aircraft Corp.	B-17G[2]			CML	6–10	4 Wr.	1200			3000		300+				85		40000+			36,000	65,000	103′ 9″	74′ 9″	19′ 1″			
	B-29[3]			CML		4 Wr	2200					All	other	data	restricted													
		307		CML	38	4 Wr	1100	SL	1,700	1675	138	250	16,200	222	19,000	70	1,200	24,400	30.2	12.7	30,000	45,000	107′ 3″	74′ 4″	20′ 10″	1486		
		314		CMF	89	4 Wr	1600	SL	5,400	4900	177	210	SL	188	SL	70			29.3	13.1	49,149	84,000	152′	106′	20′ 10″	2867		
	PT-17(N2S–4)			OBL	2	1 Con	220	SL	46	380	102	124	SL	103	SL	51	900	13,200	9.25	12.2	1,967	2,700	32′ 2″	24′ 9″	9′ 9″	297.6	23.8	3
ster Aeronautical Corp.	SB2A-2	340–26		CML	2	1 Wr	1700			1845		303				79.5		27,200			9,976	13,150	47′	39′ 2″	10′ 10″			
Aircraft Co.		A		CML	2	1 Ly	100	SL	25	362	74	112	SL	102	SL	44	725	15,500	8.53	15.5	1,042	1,550	35′ 9.5	23′ 7″	7′	181.6	21.4	8.6
ns Aircraft Co.	AT-17D	T-50		CML	3	2 Jacobs L4MB	225	SL	120	490	93	185	SL	165	SL	63	1,150	17,500	17	22	4,000	5,100	41′ 11″	32′ 9″	10′	295.9	18	10.89
	UC-78	T-50		CML	5	2 Jacobs L4MB	225	SL	150	490	93	175	SL	155	SL	66	950	15,000	19	25	4,054	5,700	41′ 11″	32′ 9″	10′	295.9	18	10.89
monwealth Aircraft, Inc.		8135	711	CML	3	1 Ken-Royce	120	SL	34	625	80	140	SL	125	SL	48	900	16,000	11.12	15.	1,130	1,800	34′	21′ 6″	7′ 4″	161.8	13.13	11.16
		8135-T	711	CML	2	1 Ken-Royce	120	SL	34	600	80	135	SL	120	SL	48	860	16,000	11.73	15.8	1,340	1,900	34′	21′ 6″	7′ 4″	161.8	13.13	11.16
		175	729	CML	2	1 Con	75	SL	24	500	70	110	SL	100	SL	38	625	14,000	8.2	18.	760	1,350	36′	21′ 9″	6′ 7″	164.6	16.96	8.94
olidated Vultee Aircraft	B-24[4](PB4Y)	32		CML	5–8	4 P&W	1200			3000+	139	300+		200		79		35000+	50	11	34,300	60,000	110′	66′ 4″	17′ 11″	1048	64.3	123
orp.	C-87	32		CML	25	4 P&W	1200			3000+	139	300+		200		79		35,000	52.5	16.5	31,330	60,000	110′	66′ 4″	17′ 11″	1048	64.3	123
	PBY-5	28		CMA	7	2 P&W	1200		1,463	3100	145	193	7,500	125		76		15000+	25	14.6	17,500	35,000	104′	63′ 10″	18′ 11″	1400		
	PB2Y-3	29		CMF	10	4 P&W	1200		3,075	3000+	150	200+		160		75		20,000 *	38	13.7	39,600	66,000	115′	79′ 3″	26′ 7″	1078		
	A-35			CML	2	1 Wr	1700																48′	39′ 9″	13′ 7″			
	BT-13			CML	2	1 P&W	450	SL	120	516	108	166		140		60	666	17,900			3,345	4,360	42′	28′ 10″	12′ 4″	239	18.2	8.06
	BT-15			CML		1 Wr	440	SL	120	516	108	166		140		60	666	17,900			3,345	4,360	42′	28′ 10″	12′ 4″	239	18.2	8.06
	L-5	V-76		CML	2	1 Ly	185	SL	25	257	85	129	SL	117	SL	42.5	975	15,800	13.3	11.2	1,492	2,065	34′	24′ 1″	7′ 1″	155	16.75	9.71
	AT-19	V-77		CML	3	1 Ly	280	SL	70	555	102	152	SL	139	SL	59	980	16,000	15.4	14.3	2,942	4,000	41′ 11″	29′ 6″	9′ 2″	258.5	22.02	12.82
er Aircraft Corp.		Cadet	730	CML	2	1 Fr	80	SL	20	480	70	140	SL	120	SL	45	800	17,500	10.88	17.4	860	1,308	27′	17′ 8″	5′ 6″	120	9.22	3.77
tiss Wright Corp.	P-40N			CML	1	1 Allison	1150	12,000		1000		350+		300		82		30,000	38.5	7.32	6,590	9,000	37′ 4″	33′ 4″	10′ 7″			
	C-46[5]			CML		2 P&W R-2800	2000	SL	1,400	1500	161	265	13,000	227	10,000	71		24,500	33.09	14.06	29,483	45000+	108′ 1″	76′ 4″	21′ 9″	1,360	79.2	115.4
	AT-9			CML	2	2 Ly	280		130	750		200+	SL	175	SL	65			24.78	10.29	4,494	5,764	40′ 3″	31′ 8″	9′ 10″			
	SB2C-1(A-25)			CML	2	1 Wr	1700			1200		300		250				25,000					49′ 9″	36′ 8″	16′ 11″			
	SO3C-1			CML	2	1 Ranger	520	SL		1000*		175+	SL					15000+					38′ 10″	35′ 8″	16′ 7″			
las Aircraft Co., Inc.	P-70			CML	2	2 Wr.	1600	5,000	540		135	325+	14,500	280	14,000	98	2,000	25000+	43.01	7.4		19,000*	61′ 4″	47′ 7″	17′ 7″	464.1	42.1	25.0
	A-20[6]			CML	3	2 Wr	1700	5,000	540		135	320+	14,500	280	14,000	98	2,000	20000+	43.01	7.4		19,750	61′ 4″	47′ 3″	18′ 1″	464.1	42.1	25.0
	TBD			CML	3	1 P&W	900			900*		200+						20000+				9,300	50′		35′			
	SBD-5(A-24B)			CML	2	1 Wr	1000	900	260	773	130	255	14,000	185	14,000	78	1,430	25,200	29.3	9.5	6,535	9,519	41′ 6″	33′ 1″	15′ 7″	325	18.23	12.78
	C-47	DC-3		CML	32	2 P&W	1050	7,500	822	2000+	138	230	8,500	185	10,000	67	1,170	24,100	25.3	12.0	16,970	29,000	95′	64′ 6″	16′ 11″	987	102.8	47.1
	C-53	DC-3		CML	32	2 P&W	1050	7,500	822	2000+	138	229	8,500	185	10,000	67	1,170	24,100	25.3	12.0	16,970	31,000	95′	64′ 6″	16′ 11″	987	102.8	47.1
	C-54	DC-4		CML	32	4 P&W	1100	7,000	3,642	3000+	157	285		222	10,000	80	1,200	26,600	35.56	11.8		66,000	117′ 6″	93′ 10″	27′ 6″	1462	123.4	72.5
neering & Research Corp.		A718-1		CML	2	1 Con	75	SL	23	500	72								9.1	17.3		1,300	30′	20′ 2″	5′ 11″	142.6	16.8	3.3
hild Eng. & Aircraft Corp.	AT-21A[7]			CML	5	2 Ranger	450	SL	225	736		210		184			1,040	20,000	30.1	12.5	8,637	11,287	53′	37′ 8″	15′	375		
	PT-19B[8]	M-62A		OML	2	1 Ranger	175	SL	45	475	86	121	SL	100	SL	52	560	13,000	13.2	15.0	1,931	2,632	36′	27′ 8″	7′ 6″	200	16.72	6.15
	PT-23	PT-23		OML	2	1 Con	220	SL	45	383	90	124	SL	104	SL	54		12,300	13.7	12.5	2,046	2,747	36′	25′ 11″	11′ 8″	200	16.72	6.15
	UC-61A	24W41A		CML	4	1 Warner	165	SL	60	525	86	110		104		54		11,400	14.5	17	1,732	2,801	36′ 4″	23′ 10″	7′ 7.5″	193.3	22	11
	C-82			CML		2				3000*	All	other	data	restri	cted													
	BT-12			CML	2	1 P&W	450	SL	120	600	105	177	SL	145	SL	60–			19.50	10.42	3,841	4,691	40′ 4″	29′ 2″	11′ 9″	240.42		8.39
ther Aviation Corp.		FBT-2		CML	2	1 Wr R-760	300	5,000	50	500	96	175	5,000	155	5,000	55	1,000	25,000	19	8.5	2,000	2,500	34′	23′ 5″	10′ 2″	132	10.76	7.01
k Aircraft Corp.		B-75L	715	CML	2	1 Ly	75	SL	16	350	76	112	SL	103	SL	37	800	17,000	8	18	800	1,350	35′	20′	6′	169	23	7.94
eral Aircraft Corp.		G1-80[9]	742	CML	2	1 Ly	75		20	400		100		92		44	550		11.2	18.0	875	1,350	31′ 5″	22′	8′ 8″	121.3	13.7	25.0
e Aircraft Corp.		GC-1"Swift"	753	CML	2	1 Con	80	SL	19.5	550	72	140	SL	125	SL	47	600	14,000	11.22	18.2	941	1,459	29′	18′ 10″	5′ 9″	130	11.32	3.39
man Aircraft Engr. Corp.	F-4F3[10]			CML	1	1 P&W	1200			1000+		300+						30000+				6,100	38′	28′ 11″	9′ 2″			
	F-6F			CML	1	1 P&W	2000					400+						35000+										
	TBF[11]			CML	3	1 Wr	1700			1000+		250+						20000+				12,000	54′ 2″	40′	16′ 5″			
	JRF-6B			CMA	8	2 P&W	450		220	1000		201		190			1,300	22,000			5,530	7,955	49′	38′	12′	375		
	J4F-1			CMA	4–5	2 Ranger	200	SL	108	775	82	164	SL	150	SL	58	1,000	15,500			3,050	4,500	40′	31′		245		
low Aircraft Co.		PC-5A	735	CML	2	1 Warner	165	SL	34	425	84	163		145		56	700	16,000	14.05	15.75	2,015	2,600	35′	23′ 7″	7′ 8″	185	13.02	12.58
		PJC-2	659	CML	4	1 Warner	140	SL	34	500	84			135		53	660	15,500	14.05	17.94	1,700	2,600	35′	23′ 4″	7′ 3″	185	13.02	12.58
vard Aircraft Corp.		DGA		OML	1	1 Warner	125	SL	31	300	87	120		108			623	14,000			1,595	2,200	34′	20′ 2″	5′ 7″	179.5	19.10	8.55
	NH-1			CML																								
estate Aircraft & Eng. Corp.	L-6	5-1B1	754	CML	2	1 Fr	113	SL	20	270	76	114	SL	105	SL	39	900	16,500	9.49	14.6	1,103	1,650	35′ 6″	23′ 5″	7′ 4″	173.8	19.35	7.95
heed Aircraft Corp.	P-38	422		CML	1	2 Allison	1150			750	138	400+						35000+	48			18000+	52′	37′ 10″	9′ 10″			
	A-29(PBO)	414		CML	5	2 Wr or P&W	1200			2090	126	275		246		72		24,500	33.5	9.25		18,500	65′ 6″	44′ 4″	11′ 11″	551	35	29.3
	C-60	18–14	723	CML	17	2 P&W or Wr	1200			1540	126	276		248		70		27,000	33.5	8.8		18,500	65′ 6″	49′ 10″	11′ 11″	551	35	29.3
	C-69	49		CML	57	4 Wr	2000					350+		325+				35,000	All	other	data	restricted						
rtin Co., Glenn L.	A-30			CML	4	2 Wr	1600				145	300+										21,000	61′ 4″	45′ 1″	17′ 8″	538	37.5	29.6
	B-26C			CML	7	2 P&W	2000				162	300+						20000+				35,000	71′	58′ 2″	21′ 6″	664	44.7	33.5
	PBM-3			CMF	9–12	2 Wr	1700			3000+	180	200+						15000+				40,000	118′	80′	27′ 6″	1408	75.4	58.5
	PB2M-1			CMF	22	4 Wr	2200							160+								140,000	200′	117′				
row Aircraft Corp.	Trainer	IL		CML	2	1 Ly	185	SL	27	395	88	180	SL	153	SL	60	1,250	19,000	16.85	13	1,886	2,400	30′	25′ 8″	7′ 9″	142.5	9.78	7.48
h American Aviation, Inc.	P-51[12]	NA102		CML	1	1 Packard R-R	1500	17,000			134	400+	30,000			87		30000+	36	5.5	6,950	10,000*	37′	33′	11′ 9″	233.19	12.72	9.61
	B-25H[13](PBJ)			CML	5	2 Wr. R-2600	1700	13,000			91	300+	15,000	239	15,000	95		25,000	44	20	20,306	35000+	67′ 7″	51′ 11″	15′ 9″	609.8	32.13	57.4
	AT-6C(SNJ-4)	NA-88		CML	2	1 P&W	600	5,000	111	750	108	205	5,000	190	SL	72	1,750	21,500	20	9.5	4,138	5,280	42′	29′	11′ 9″	253	11.40	5.33
hrop Aircraft, Inc.	N-3PB			CMFl	3	1 Wr	1100		270	1000	126	257	16,400	217	16,400			24,000	22.5	8.95	6,190	10,600	48′ 11″	36′	12′	376.8		
	P-61			CML		2 P&W	All	other	data	restric	ted																	
r Aircraft Corp.	L-4H	J3C-65	691	CML	2	1 Con	65	SL	12	206	72	87	3,000	75	3,000	38	450	11,500	6.83	18.8	740	1,220	35′ 2″	22′ 5″	6′ 8″	178.5	19.2	4.0
	HE-1	J5-C	725	CML	2	1 Ly	100	SL	20	279	74	110	9,800	90	3,000	49	600	15,000	8.83	14.95	906	1,495	35′ 5″	22′ 6″	9′ 6″	179.3	19.2	4.66
	PT-1			CML	2	1 Franklin	130		40	700		150+		135+		—50	750+		12.2	15.4	1,325	2,000	34′	22′ 10″	6′ 6″	164	15.4	5.9
don Bros.		T-1		CML	2	1 Ly	125	SL		400+		128		112		45	910	16,000	9.5		1,035	1,574	33′	24′	7′	165	17.8	6.0
ublic Aviation Corp.	P-47			CML	1	1 P&W	2000					400+						35,000*				13500+	40′	36′ 1″	14′ 2″	300		
h Aeronautical Co.	PT-22(NR-1)	ST-3		CML	2	1 Kinner	160	SL	24	325	94	128	SL	116	SL	54	860	14,800	13.8	11.6	1307.5	1,860	30′	22′	7′ 2″	134.2	11.12	4.64
	PT-25	ST-4		OML	2	1 Ly	185	SL	27	378	88	149	SL	134	SL	54	1,590	20,300	11.1	9.7	1,235	1,800	32′	24′	8′ 6″	161.2	16.66	5.2
lorcraft Aviation Corp.	L-2M			CML	2	1 Con	65	SL	14	275	72	97		90		34	436	13,000	7.28	20.4	886	1,325	35′	22′	7′	186.7	10.15	5.6
n Aircraft Corp.	XN2T-2			OML	2	1 Ly	210		42	340	94	136		120		54	1,000	15,000	14.75	12.95			36′	24′	7′ 10″	184.9	20.76	9.49
	N2T-1		31	OML	2	1 Con	220		42	340	94	135		115		54	1,000	15,000	14.75	12.4		2,725	36′	24′ 7″	10′ 8″	184.9	20.76	11.84
a Aircraft Corp.	B-34(PV-1)	V-146		CML	4	2 P&W	2000			1000		300+				80		30,000	40.9			30,000	65′ 6″	51′ 5″	11′ 11″	551		
ght Division of United.	F4U-1[14]			CML	1	1 P&W	2000			1500+		400*						35000+					41′	33′ 4″	16′ 1″			
ft Corp.	SB2U-3			CML	2	1 P&W	825			700		257		227								6,500	42′	34′	9′ 10″			
	OS2U-3			CML	2	1 P&W	450			1000+		175+						15000+					36′	33′ 10″	15′			
	TBY-1[15]																											
		VS-44A		CMF	45	4 P&W	1200			3800		225		175			900					57,500	124′	79′ 3″	24′ 7″			

—Approximate
—Amphibian
—Aluminum alloy
—Biplane
—Box spar
—Closed
—Continental
—Flying Boat
—Fabric

Fl —Floats
Fr —Franklin
Fx —Fixed
Gen —General
Go —Goodyear
Hyd —Hydraulic
Id —Inverted
L —Landplane
Lmd —Laminated

Ly —Lycoming
M —Monoplane
Me —Metal
Mech—Mechanical
Mo —Monocoque
O —Open
Oi —Oleo
Ply —Plywood
Pn —Pneumatic

P&W—Pratt & Whitney
Re —Retractable
S —Steel
SL —Sea level
Sh —Shinn
Sol —Solid
Sp —Spruce
Spr —Spring
SS —Stainless Steel

T —Tubing
T.T. —Troop Transport
Trs —Truss
Tri —Tricycle
W —Wood
Wl —Weld
Wh —Wheel
Wr —Wright

[1] Also manufactured by Globe Aircraft Corp.
[2] Also manufactured by Douglas Aircraft Co. and Vega Aircraft.
[3] Also manufactured by Bell Aircraft and Glenn L. Martin Co.
[4] Also manufactured by Douglas Aircraft Co., Ford Motor Co. and North American Aviation, Inc.
[5] Also to be produced by Higgins Aircraft, Inc.
[6] Also manufactured by Nashville Div., Consolidated Vultee Aircraft Corp.
[7] Also manufactured by Bellanca Aircraft Corp. and McDonnell Aircraft Corp.
[8] Also manufactured by Aeronca Air-

...erican Aircraft Specifications

...rmance				Weights				Dimensions			Area (Sq. Ft.)						Wings			
At altitude, ft.	Stalling speed, mph.	Climb at sea level, ft. per min.	Service ceiling	Wing loading (lb. per sq. ft.)	Power loading (lb. per hp.)	Weight empty	Gross weight, lb.	Span	Length overall	Height overall	Wing (including ailerons)	Ailerons (total)	Fin	Rudder	Stabilizer	Elevators (total)	Spars	Ribs	Covering material	
	46	404	10,000	7.69	20	870	1,300	35′	21′ 10″	9′ 1″	169	15.52	5.51	6.8	13.66	11.54	W	WTrs	Fab	Fi
	60	695	13,300	15.45	14.70	1,738	2,650	35′	20′ 10″	7′ 1″	171.5	16.66	4.06	3.98	18.8	10.65	Ply	Ply	Ply	Fi
	48	580	14,000	10.9	16	998	1,850	34′	24′ 4″	7′ 10″	170	18.80	10.2	6.87	22.22	10.17	Sp	Sp	Fab	Re
,000	61	1,660	24,000	22.5	8.7	5,815	7,850	47′ 8″	34′ 3″	9′ 4″	349	22.8	16.3	17.28	38.18	27.2	StWld	Al	Al	Re
,000	65	1,125	20,000	25	9.7	6,158	8,727	47′ 8″	34′ 2″	9′ 8″	349	22.8	16.3	17.28	38.18	26.22	StWld	Al	Al	Re
,000	50	1,500	24,300	14.3	9.45	3,085	4,250	32′	26′ 1″	8′	296.4	22.96	6.5	8.71	24.48	16.56	SolSp	SpPly	Fab	Re
	.....	.....	35000+	35.5	6.58	5,523	7,496	34′	30′ 2″	9′ 3″	213.2	15.46	7.9	11	24.1	16.8	Me	Me	Me	Re
	85	.....	40000+	.....	.....	36,000	65,000	103′ 9″	74′ 9″	19′ 1″	.....	.....	.....	.....	.....	.....	Me	Me	Me	Re
stric	ted																			
,000	70	1,200	24,400	30.2	12.7	30,000	45,000	107′ 3″	74′ 4″	20′ 10″	1486	.....	.....	.....	.....	.....	Me	Me	Me	Re
	70	.....	.....	29.3	13.1	49,149	84,000	152′	106′	20′ 10″	2867	.....	.....	.....	.....	.....	Me	Me	Me	..
	51	900	13,200	9.25	12.2	1,967	2,700	32′ 2″	24′ 9″	9′ 9″	297.6	23.8	3	11.8	21	14	SolSp	SpTrs	Fab	Fx
	79.5	.....	27,200	.....	.....	9,976	13,150	47′	39′ 2″	10′ 10″	.....	.....	.....	.....	.....	.....	Me	Me	Me	Re
	44	725	15,500	8.53	15.5	1,042	1,550	35′ 9.5	23′ 7″	7′	181.6	21.4	8.6	10	15.8	14.0	LmdSp	Sp	Fab	Fx
	63	1,150	17,500	17	22	4,000	5,100	41′ 11″	32′ 9″	10′	295.9	18	10.89	14.89	39.22	23.46	Sp	Sp	Fab	Re
	66	950	15,000	19	25	4,054	5,700	41′ 11″	32′ 9″	10′	295.9	18	10.89	14.87	39.22	23.46	Sp	Sp	Fab	Re
	48	900	16,000	11.12	15.	1,130	1,800	34′	21′ 6″	7′ 4″	161.8	13.13	11.16	5.75	13.94	11.56	W	W	Fab	Fx
	48	860	16,000	11.73	15.8	1,340	1,900	34′	21′ 6″	7′ 4″	161.8	13.13	11.16	5.75	13.94	11.56	W	W	Fab	Fx
	38	625	14,000	8.2	18.	760	1,350	36′	21′ 9″	6′ 7″	164.6	16.96	8.94	5.91	14.76	10.88	W	W	Fab	Fx
	79	.....	35000+	50	11	34,300	60,000	110′	66′ 4″	17′ 11″	1048	64.3	123	48.8	140.5	192	Me	Me	Me	Re
	79	.....	35,000	52.5	16.5	31,330	60,000	110′	66′ 4″	17′ 11″	1048	64.3	123	48.8	140.5	192	Me	Me	Me	Re
	76	.....	15000+	25	14.6	17,500	35,000	104′	63′ 10″	18′ 11″	1400	.....	.....	.....	.....	.....	Me	Me	Me	Re
	75	.....	20,000 *	38	13.7	39,600	66,000	115′	79′ 3″	26′ 7″	1078	.....	.....	.....	.....	.....	Me	Me	Me	..
	.....	.....	.....	.....	.....	.....	.....	48′	39′ 9″	13′ 7″	.....	.....	.....	.....	.....	.....	Me	Me	Al	Re
	60	666	17,900	.....	.....	3,345	4,360	42′	28′ 10″	12′ 4″	239	18.2	8.06	10.56	24.41	19.22	Me	.....	Al	Fx
	60	666	17,900	.....	.....	3,345	4,360	42′	28′ 10″	12′ 4″	239	18.2	8.06	10.56	24.41	19.22	Me	.....	Al	Fx
	42.5	975	15,800	13.3	11.2	1,492	2,065	34′	24′ 1″	7′ 1″	155	16.75	9.71	7.05	21.8	15.62	WBox	W	WFab	Fx
	59	980	16,000	15.4	14.3	2,942	4,000	41′ 11″	29′ 6″	9′ 2″	258.5	22.02	12.82	14.45	25.06	19.94	ST,Trs	Trs	Fab	Fx
	45	800	17,500	10.88	17.4	860	1,308	27′	17′ 8″	5′ 6″	120	9.22	3.77	3.57	12.40	5.26	LmdSp	W	Fab	Re
	82	.....	30,000	38.5	7.32	6,590	9,000	37′ 4″	33′ 4″	10′ 7″	.....	.....	.....	.....	.....	.....	Al	Al	Al	Re
,000	71	.....	24,500	33.09	14.06	29,483	45000+	108′ 1″	76′ 4″	21′ 9″	1,360	79.2	115.4	52.8	158.5	98.4	Al	Al	Al	Re
	65	.....	.....	24.78	10.29	4,494	5,764	40′ 3″	31′ 8″	9′ 10″	.....	.....	.....	.....	.....	.....	Me	Me	Me	Re
	.....	.....	25,000	.....	.....	.....	.....	49′ 9″	36′ 8″	16′ 11″	.....	.....	.....	.....	.....	.....	Me	Me	Al	Re
	.....	.....	15000+	.....	.....	.....	.....	38′ 10″	35′ 8″	16′ 7″	.....	.....	.....	.....	.....	.....	Me	Me	Al	Fx
,000	98	2,000	25000+	43.01	7.4	.....	19,000*	61′ 4″	47′ 7″	17′ 7″	464.1	42.1	25.0	35.2	60.8	39.1	Me	Me	Me	Re
,000	98	2,000	20000+	43.01	7.4	.....	19,750	61′ 4″	47′ 3″	18′ 1″	464.1	42.1	25.0	35.2	60.8	39.7	Me	Me	Me	Re
	.....	.....	20000+	.....	.....	.....	9,300	50′	35′	15′ 1″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
,000	78	1,430	25,200	29.3	9.5	6,535	9,519	41′ 6″	33′ 1″	15′ 7″	325	18.23	12.78	9.88	52.23	18.60	Me	Me	Me	Re
,000	67	1,170	24,100	25.3	12.0	16,970	29,000	95′	64′ 6″	16′ 11″	987	102.8	47.1	46.3	127.9	82.3	Me	Me	Al	Re
,000	67	1,170	24,100	25.3	12.0	16,970	31,000	95′	64′ 6″	16′ 11″	987	102.8	47.1	46.3	127.9	82.3	Me	Me	Al	Re
,000	80	1,200	26,600	35.56	11.8	.....	66,000	117′ 6″	93′ 10″	27′ 6″	1462	123.4	72.5	63.4	206.2	119.0	Me	Me	Al	Re
	.....	.....	.....	9.1	17.3	.....	1,300	30′	20′ 2″	5′ 11″	142.6	16.8	3.3	6.	10.2	9.4	Me	Me	Me	Fx
	.....	1,040	20,000	30.1	12.5	8,637	11,287	53′	37′ 8″	15′	375	.....	.....	.....	.....	.....	WBox	WTrs	Ply	Re
	52	560	13,000	13.2	15.0	1,931	2,632	36′	27′ 8″	7′ 6″	200	16.72	6.15	14.5	26.77	13.23	WBox	WTrs	Ply	Fx
	54	.....	12,300	13.7	12.5	2,046	2,747	36′	25′ 11″	11′ 8″	200	16.72	6.15	14.5	26.77	13.23	SpBox	WTrs	Ply	Fx
	54	.....	11,400	14.5	17	1,732	2,801	36′ 4″	23′ 10″	7′ 7.5″	193.3	22	11	12	37	19	Sp	Sp	Fab	Fx
d	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	..
	60–	.....	.....	19.50	10.42	3,841	4,691	40′ 4″	29′ 2″	11′ 9″	240.42	.....	8.39	12.94	22.74	18.56	SS	SS	SS	Fx
000	55	1,000	25,000	19	8.5	2,000	2,500	34′	23′ 5″	10′ 2″	132	10.76	7.01	5.75	16.6	13.7	W	W	Plasti-Pl.	Fx
	37	800	17,000	8	18	800	1,350	35′	20′	6′	169	23	7.94	7	.....	10	Sp	Sp	Fab	Fx
	44	550	.....	11.2	18.0	875	1,350	31′ 5″	22′	8′ 8″	121.3	13.7	25.0	.....	16.6	8.3	Al	Al	Fab	Fx
	47	600	14,000	11.22	18.2	941	1,459	29′	18′ 10″	5′ 9″	130	11.32	3.39	4.93	11.00	7.43	W	W	Fab	Re
	.....	.....	30000+	.....	.....	.....	6,100	38′	28′ 11″	9′ 2″	.....	.....	.....	.....	.....	.....	Me	Me	Me	Re
	.....	.....	35000+	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Me	Me	Me	Re
	.....	.....	20000+	.....	.....	.....	12,000	54′ 2″	40′	16′ 5″	.....	.....	.....	.....	.....	.....	Me	Me	Me	Re
	.....	1,300	22,000	.....	.....	5,530	7,955	49′	38′	12′	375	.....	.....	.....	.....	.....	Me	Me	Me	Re
	58	1,000	15,500	.....	.....	3,050	4,500	40′	31′	9′	245	.....	.....	.....	.....	.....	Me	Me	Me	Re
	56	700	16,000	14.05	15.75	2,015	2,600	35′ 7″	23′ 7″	7′ 8″	185	13.02	12.58	10.9	21.2	17.12	Me	Me	Me	Re
	53	660	15,500	14.05	17.94	1,700	2,600	35′ 8″	23′ 4″	7′ 3″	185	13.02	12.58	10.9	21.2	17.12	Me	Me	Me	Re
	.....	623	14,000	.....	.....	1,595	2,200	34′	26′ 2″	5′ 7″	179.5	19.10	8.55	6.77	15.3	14.3	.....	.....	.....	Fx
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Fx
	39	900	16,500	9.49	14.6	1,103	1,650	35′ 6″	23′ 5″	7′ 4″	173.8	19.35	7.95	8.1	16.06	12.24	Sp	Al	Fab	Fx
	.....	.....	35000+	48	.....	.....	18000+	52′	37′ 10″	9′ 10″	.....	.....	.....	.....	.....	.....	Me	Me	Me	Re
	72	.....	24,500	33.5	9.25	.....	18,500	65′ 6″	44′ 4″	11′ 11″	551	35	29.3	34.8	93.6	40.4	Al	Al	Al	Re
	70	.....	27,000	33.5	8.8	.....	18,500	65′ 6″	49′ 10″	11′ 11″	551	35	29.3	34.8	93.6	40.4	Al	Al	Al	Re
	.....	.....	35,000	All	other	data	restricted													Re
	.....	.....	.....	.....	.....	.....	21,000	61′ 4″	45′ 1″	17′ 8″	538	37.5	29.6	32.9	73.3	56	Me	Me	Me	Re
	.....	.....	20000+	.....	.....	.....	35,000	71′	58′ 2″	21′ 6″	664	44.7	33.5	33.7	90.8	52.9	Me	Me	Me	Re
	.....	.....	15000+	.....	.....	.....	40,000	118′	80′	27′ 6″	1408	75.4	58.5	37.7	145.3	96.02	Me	Me	Me	..
	.....	.....	.....	.....	.....	.....	140,000	200′	117′								Me	Me	Me	..
	60	1,250	19,000	16.85	13	1,886	2,400	30′ 4″	25′ 8″	7′ 9″	142.5	9.78	7.48	8.53	20.73	17.75	WBox	W	Ply	Re
	87	.....	30000+	36	5.5	6,950	10,000*	37′	33′	11′ 9″	233.19	12.72	9.61	10.41	27.98	13.05	Al	Al	Alclad	Re
,000	95	.....	25,000	44	20	20,306	35000+	67′ 7″	51′ 11″	15′ 9″	609.8	32.13	57.4	33.6	92	40.4	Al	Al	Alclad	Re
	72	1,750	21,500	20	9.5	4,138	5,280	42′	29′	11′ 9″	253	11.40	5.33	13.21	28.34	10.88	Al	Al	Alclad	Re
400	.....	.....	24,000	22.5	8.95	6,190	10,600	48′ 11″	36′	12′	376.8	.....	.....	.....	.....	.....	Me	Me	Me	Ec
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
,000	38	450	11,500	6.83	18.8	740	1,220	35′ 2″	22′ 5″	6′ 8″	178.5	19.2	4.0	6.53	14.65	10.64	W	Nicral	Fab	Fi
,000	49	600	15,000	8.83	14.95	906	1,495	35′ 5″	22′ 6″	9′ 6″	179.3	19.2	4.66	6.76	14.66	10.64	W	Nicral	Fab	Fi
	—50	750+	.....	12.2	15.4	1,325	2,000	34′	22′ 10″	6′ 6″	164	15.4	5.9	5.8	15.2	12.2	WBox	W	Ply	Re
	45	910	16,000	9.5	.....	1,035	1,574	33′ 3″	24′	7′ 2″	165	17.8	6.0	5.8	16.5	11.5	W	W	Fab	Fi
	.....	.....	35,000*	.....	.....	.....	13500+	40′ 8″	36′ 1″	14′ 2″	300	.....	.....	.....	.....	.....	Me	Me	Me	Re
	54	860	14,800	13.8	11.6	1307.5	1,860	30′ 1″	22′ 5″	7′ 2″	134.2	11.12	4.64	7.75	14.48	11.00	W	Al	Fab	Fi
	54	1,590	20,300	11.1	9.7	1,235	1,800	32′ 10″	24′ 4″	6′ 8″	161.2	16.66	5.2	7.83	18.62	13.75	W	W	Ply	Fi
	34	436	13,000	7.28	20.4	886	1,325	35′ 5″	22′ 5″	7′	186.7	10.15	5.6	5.76	13.0	10.66	SolSp	MeW	Fab	Fi
	54	1,000	15,000	14.75	12.95	.....	.....	36′	24′ 7″	10′ 8″	184.9	20.76	9.49	11.78	26.12	15.34	LmdBox	TrsSp	Ply	Fi
	54	1,000	15,000	14.75	12.4	.....	2,725	36′	24′ 7″	10′ 8″	184.9	20.76	11.84	11.78	26.12	15.34	LmdBox	TrsSp	Ply	Fi
	80	.....	30,000	40.9	.....	.....	30,000	65′ 6″	51′ 5″	11′ 11″	551	.....	.....	.....	.....	.....	.....	.....	.....	.....
	.....	.....	35000+	.....	.....	.....	.....	41′	33′ 4″	16′ 1″	.....	.....	.....	.....	.....	.....	Me	Me	Me	Re
	.....	.....	.....	.....	.....	.....	6,500	42′	34′	9′ 10″	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	.....	.....	15000+	.....	.....	.....	.....	36′	33′ 10″	15′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	.....	.....	900	.....	.....	.....	57,500	124′	79′ 3″	24′ 7″	.....	.....	.....	.....	.....	.....	Me	Me	Me	..

[1] Also manufactured by Globe Aircraft Corp.
[2] Also manufactured by Douglas Aircraft Co. and Vega Aircraft.
[3] Also manufactured by Bell Aircraft and Glenn L. Martin Co.
[4] Also manufactured by Douglas Aircraft Co., Ford Motor Co. and North American Aviation, Inc.
[5] Also to be produced by Higgins Aircraft, Inc.
[6] Also manufactured by Nashville Div., Consolidated Vultee Aircraft Corp.
[7] Also manufactured by Bellanca Aircraft Corp. and McDonnell Aircraft Corp.
[8] Also manufactured by Aeronca Aircraft Corp.
[9] Being produced under license by Grand Rapids Industries, Inc.
[10] Also manufactured by Eastern Aircraft Div., General Motors Corp., under Navy designation FM-1.
[11] Also manufactured by Eastern Aircraft Div., General Motors Corp., under Navy designation TBM.
[12] Earli... A di... A-36...
[13] A ne... canno...
[14] Also ... Aircr... tion ... nauti...

Although the data given are from reliable sources and have been checked from every possible angle, Aviation cannot assume responsibility for the figures given.

ngs		Landing Gear						
	Covering material	Type	Tread (in.)	Wheel type and size	Brakes (type and make)	Landing gear shock unit (type and make)	Tail unit	Fuselage or Hull
	Fab	Fx	70	600x6	Mech	Spr,Ol	Spr,Ol	ST,Wl,Fab
	Ply	Fx	120	6.50x8	Go	And. Hyd	Wh	Ply
	Fab	Re	68	Go 6.00x6	Go	Dart	Dart	Me
	Al	Re	155	Pn 29x13.5	Hyd	Air,Ol	Re	Al
	Ply	Re	152	Pn 27 in. sm.	Hyd	Air,Ol	Fx,Wh	.....
	Al	Re	155	Pn 33½in. sm.	Hyd	Air,Ol	Re,Wh	.....
	Fab	Re	86	Pn 7.50x10	Hyd	Spr,Ol	Re	.....
	Me	ReTri	136	Main 26x6	Hyd	Warner	.....	Me
	Me	Re	.....	.....	Hyd	.....	Wh	Me
	Me	Re	.....	.....	.....	.....	Wh	Me
	Me	.....	.....	.....	.....	.....	.....	Me
	Fab	Fx	77.5	24 in.	Hyd	Cleve,Pn	Wh	Wld,St,Fab
	Me	Re	.....	.....	.....	.....	Wh	Me
	Fab	Fx	98	Hayes 8.00x4	Hayes Hyd	Spr,Ol	Spr,Wh	ST,Fab
	Fab	Re	151¼	Hayes7.50x10	Hayes	Bendix, Pn	Fx,Wh	ST,Wl,Fab
	Fab	Re	151¼	Hayes7.50x10	Hayes	Bendix, Pn	Fx,Wh	ST,Wl,Fab
	Fab	Fx	82	Go 18.00x8	Go Mech	Sp	Wh	.....
	Fab	Fx	82	Go 18.00x8	Go Mech	Sp	Wh	.....
	Fab	Fx	74	Go 18.00x8	Hyd	Hyd	Wh	.....
	Me	ReTri	307.5	Hayes 56" sm.	Hayes	Bendix	.....	Me
	Me	ReTri	307.5	Hayes 56" sm.	Hayes	Bendix	.....	Me
	Me	ReTri	.....	.....	.....	.....	.....	Me
	Me	.....	.....	.....	.....	.....	.....	Me
	Al	Re	136	36 in. sm.	Hyd Go	Ol	.....	Me
	Al	Fx	126.5	27 in. sm.	Hyd	.....	St,Wh	Me
	Al	Fx	126.5	27 in. sm.	Hyd	.....	St,Wh	Me
	WFab	Fx	86.43	Hayes 6.00x6	Hyd	Spr,Hyd	St,Wh	ST,Fab
	Fab	Fx	113.5	Hayes7.50x10	Hyd	Spr,Hyd	St,Wh	ST,Fab
	Fab	Re	79	Hayes 5.00x4	Hyd	Ol,Sp	Wh	Semi-Mo
	Al	Re	.....	27 in.	Hyd	Ol,Pn	Re,Wh	Al.Semi-Mo.
	Al	Re	311	55x19	Hyd	Aerol	Re,Wh	Al.Semi-Mo.
	Me	Re	.....	.....	.....	Cleve	Fx,Wh	Me
	Al	Re	.....	.....	.....	Ol,Hyd	Wh	Me.Semi-Me
	Al	Fx	.....	.....	.....	Ol	Wh,Fx	Al.Semi-Mo.
	Me	ReTri	203½	Go 44 in.	Hyd	Ol,Pn	Go 26 in.	Me
	Me	ReTri	203½	Go 44 in.	Hyd	Ol,Pn	Go 26 in.	Me
	Me	Re	126⅜	30x7	Hyd	Ol	Wh	Me
	Al	Re	222	Bndx17.00x16	Bendix	Ol	22x9x6Wh	Me
	Al	Re	222	Bndx17.00x16	Bendix	Ol	22x9x6Wh	Me
	Al	ReTri	296	Go 17.00x20	Hyd	Ol,Pn	.....	Me
	Me	FxTri	.....	Hayes 7.00x4	Hyd	Ol	.....	Ply,Mo
	Ply	ReTri	.....	36"	Hyd	.....	.....	W,Mo
	Ply	Fx	112	6.50x10	Hyd	Spr,Ol	Spr,Ol	ST,Wl,Fab
	Ply	Fx	112	6.50x10	Hyd	Spr,Ol	Spr,Ol	ST,Wl,Fab
	Fab	Fx	111	6.50x10	Hyd	Spr,Ol	Spr,Ol	ST,Wl,Fab
	Me	.....	.....	.....	.....	.....	.....	Me
	SS	Fx	122¾	27 in. sm.	BendixHyd	Air,Ol	Wh	Me
	Plasti-Pl.	Fx	84	7.50x10	Ol	Hyd	Hyd,Wh	.....
	Fab	Fx	72	Fire 6.00x6	Firestone	Ol	Hyd,Wh	Wld,St,Fab
	Fab	FxTri	64	.....	Hyd	Ol	.....	.....
	Fab	Re	86.11	Go 600x6	Go	Ol	Ol	ST,Fab
	Me	Re	.....	.....	Hyd	.....	.....	Me
	Me	Re	.....	.....	.....	.....	.....	Me
	Me	Re	.....	.....	.....	.....	.....	Me
	Me	Re	.....	.....	.....	.....	.....	Me
	Me	Re	90	7.50x10	.....	.....	Wh	Me
	Me	Re	.....	General	.....	Oleo	St,Wh	Me.Semi-Mo
	Me	Re	.....	General	.....	Oleo	St,Wh	Me.Semi-Mo
	.....	Fx	.....	.....	.....	.....	Wh	Ply
	.....	Fx	.....	.....	.....	.....	.....	.....
	Fab	Fx	76	Fire-Sh 7x6	Fire-Sh-Hy	Sp,Ol	Wh	.....
	Me	ReTri	.....	.....	.....	.....	.....	Me
	Al	Re	184	Go 42.31x15.6	Go Hyd	Aerol	Wh	Al,Mo
	Al	Re	184	Go 42.31x15.6	Go Hyd	Aerol	Wh	Al,Mo
	.....	ReTri	.....	.....	Hyd	.....	.....	.....
	Me	Re	204	15.00x16	Gr Hyd	.....	17 in. Wh	Me
	Me	ReTri	252	47 in. sm.	Gr Hyd	.....	.....	Me
	Me	.....	.....	.....	.....	.....	.....	Me
	Me	.....	.....	.....	.....	.....	.....	Me
	Ply	Re	134.5	6.00x6	Hyd	Air,Ol	Air,Ol	W
	Alclad	Re	142	Go 27"	Hyd	Bendix	Re,Wh	Me
	Alclad	Re, Tri	196¼	47"	Hyd	Bendix, Pn	.....	Me
	Alclad	Re	.....	27"	Hyd	Bend&Clev	St,Wh	.....
	Me	Edo,Fl	.....	.....	.....	.....	.....	Me
	Fab	Fx	71	Hayes 8.00x4	Exp	Shk.Cord	Spr,Wh	ST,Wl,Fab
	Fab	Fx	71	Hayes 8.00x4	Exp	Shk,Cord	Spr,Wh	ST,Wl,Fab
	Ply	Re	100	.....	.....	Oleo	Wh	ST,Wl,Fab
	Fab	Fx	114	.....	.....	.....	.....	ST,Wl,Fab
	Me	Re	187	Bendix 34x9	Bendix	Air-Ol	Re,Air,Ol	Me
	Fab	Fx	78¾	Hayes 7.00x6	Mech,Hyd	Ol	St,Wh	Me
	Ply	Fx	80	Hayes 7.00x6	Hyd	Ol	St,Wh	Ply
	Fab	Fx	.....	6.00x6	Mech	ShkCord	Wh	ST,Wl,Fab
	Ply	Fx	107.5	Hayes 22"	Hayes	Ol	Wh	Ply
	Ply	Fx	107.5	Hayes 22"	Hayes	Ol	Wh	Ply
	.....	.....	.....	.....	.....	.....	.....	.....
	Me	Re	.....	.....	Hyd	.....	Re,Wh	Me
	.....	.....	.....	.....	.....	.....	.....	Me,Fab
	.....	.....	.....	.....	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....
	Me	.....	.....	.....	.....	.....	.....	Me

[12] Earlier models were Allison-powered A dive bomber version designated A-36 *Invader* is also in action.

[13] A new version mounts a 75-mm cannon in the nose for attack work

[14] Also manufactured by Goodyear Aircraft Corp. under Navy designation FG-1 and by Brewster Aeronautical Corp. under Navy designation F3A.

[15] Vought design being built by Consolidated Vultee Aircraft Corp; craft is known as the *Seawolf*.

† Bell is also producing the new jet propelled fighter announced last month by Gen. H. H Arnold. No data has been released on the craft.

Manufacturer	Genera Designation or Model No.
Airspeed, Ltd	Oxford V Trainer
Armstrong-Whitworth	Whitley V T.-T
Armstrong-Whitworth	Ensign Transport
A. V. Roe & Co., Ltd	Anson V Trainer
A. V. Roe & Co., Ltd	Avro Manchester IA Bombe
A. V. Roe & Co., Ltd	Avro York Transport
A. V. Roe & Co., Ltd	Avro Lancaster II Bomber
Blackburn Aircraft, Ltd	Botha I G.-P
Blackburn Aircraft, Ltd	Skua Dive Bomber
Blackburn Aircraft, Ltd	Roc Pursuit
Boulton Paul Aircraft, Ltd	Defiant II Pursuit
Bristol Aeroplane Co., Ltd	Blenheim IV Bomber
Bristol Aeroplane Co., Ltd	Beaufort II Bomber-Rec
Bristol Aeroplane Co., Ltd	Beaufighter Attack
Bristol Aeroplane Co., Ltd	Bombay Transport
De Havilland Aircraft Co., Ltd	Hertfordshire T.-T
De Havilland Aircraft Co., Ltd	Albatross Transport
De Havilland Aircraft Co., Ltd	Mosquito IV Bomber
De Havilland Aircraft Co., Ltd	Flamingo Transport
De Havilland Aircraft Co., Ltd	Comet Trainer
Fairey Aviation Co., Ltd	Battle Bomber Trainer
Fairey Aviation Co., Ltd	Fulmar Fleet Fighter
Fairey Aviation Co., Ltd	Seafox Naval Rec
Fairey Aviation Co., Ltd	Swordfish Naval Rec
Fairey Aviation Co., Ltd	Albacore-TB
Handley-Page, Ltd	Hampden I Bomber
Handley-Page, Ltd	Halifax II A Bomber
Hawker Aircraft, Ltd	Hurricane II C Interceptor
Hawker Aircraft, Ltd	Typhoon I B Pursuit
Phillips & Powis, Ltd	Magister-Trainer
Phillips & Powis, Ltd	Master-Trainer
Phillips & Powis, Ltd	Proposed Cargo-Transport
Noorduyn, Ltd	Norseman-Transport
Saunders Roe, Ltd	Lerwick-Coastal Rec
Short Bros., Ltd	Sunderland III Naval Rec
Short Bros., Ltd	Stirling II Heavy Bomber
Short Bros., Ltd	Short G. Transport
Vickers-Armstrong, Ltd	Wellington III Bomber
Supermarine	Spitfire V Interceptor
Supermarine	Spitfire V Clipwing
Supermarine	Spitfire IX Interceptor
Westland Aircraft, Ltd	Lysander III Army Co-op
Westland Aircraft, Ltd	Whirlwind
Arado Flugzeugwerke G.m.b.H	AR. 95 Bomber-Seaplane
Arado Flugzeugwerke G.m.b.H	AR. 196A Fighter-Seaplane
Blohm & Voss	Ha 138 Reconnaissance
Blohm & Voss	Ha. 139-B Observation
Blohm & Voss	Ha. 140 Torpedo Bomber
Blohm & Voss	Ha. 141 Reconnaissance
Blohm & Voss	BV.-142 T. T
Blohm & Voss	BV.-222 T. T
Bücker	BU. 181 Bestmann Trainer
Dornier-Werke G.m.b.H	Do. 17-Z Bomber
Dornier-Werke G.m.b.H	Do. 26 Bomber-Rec
Dornier-Werke G.m.b.H	Do. 215 Bomber
Dornier-Werke G.m.b.H	Do. 217E Bomber
Fieseler	Fl. 156 Observation
Fieseler	Fl. 167 Observation
Focke-Wulf G.m.b.H	Fw. 187 Pursuit
Focke-Wulf G.m.b.H	Fw. 189 Observation
Focke-Wulf G.m.b.H	190A3 Fighter
Focke-Wulf G.m.b.H	Fw. 198 Fighter
Focke-Wulf G.m.b.H	Fw. 200K2 Kurier Bomber
Heinkel	HE 112 Fighter
Heinkel	HE 113 Fighter
Heinkel	HE 115 Naval Rec
Heinkel	HE-177 Bomber
Heinkel	HE 111-K-V-A-H Bomber
Henschel	HS 126 Rec
Henschel	HS 129 Fighter-Bomber
Junkers	JU. 52 T.-T
Junkers	JU. 87-K Dive Bomber
Junkers	JU. 88-K Bomber
Junkers	JU. 86 P-1 Bomber
Junkers	JU. 90 T.-T
Junkers	JU. 290 T.-T
Messerschmitt	ME 108 Observation
Messerschmitt	ME 109-G Fighter
Messerschmitt	ME 110-C5 Fighter
Messerschmitt	ME. 210 Fighter-Bomber
Messerschmitt	ME. 323 T.-T
Messerschmitt	ME. 410
Mitsubishi	Zero (Zeke) Fighter
Mitsubishi	Zero (Hap) Fighter
Mitsubishi	Zero (Rufe) Fighter
Mitsubishi	Type 96 (Claude) Fighter
Mitsubishi	Type 97 (Nate) Fighter
Nakajima	Type 01 (Oscar) Fighter
	Type 03 (Tony) Fighter
Showa	Type 98 Fighter-Bom
Aichi	Type 99 (Val) Dive-Bombe
Kawasaki	Type 97 Torpedo-Bo
Nakajima	Type 96 Torpedo-Bo
Nakajima	Type 97 (Kate) Torpedo-Bo
Kawanishi	Type 97 Bomber
Mitsubishi	Type 96 (Nell) Bomber
Mitsubishi	Type 97 (Sally-1) Bomber
Mitsubishi	Type 97 (Sally-2) Bomber
Mitsubishi Karigane III	Type 98 (Ida) Bomber
Mitsubishi	Type 98 Bomber
Mitsubishi	Type 01 (Betty) Bomber
Nakajima	Type 97 Bomber
	Type T-00 (Dinah) Reconn-Bo
Kawasaki	Type 97 KB Reconn-Bom
Mitsubishi	Type 97 (Kamakaze) Reconn
	Type 99 (Lily) Reconn-Bom
Mitsubishi	Mc-20 (Topsy) Transport
Nakajima	Transport
Mitsubishi	Bomb.-Tran
Aichi	Type 00 (Jake) Reconn.
Aichi	Type 97 Reconn
Kawanishi	Type 97 (Mavis) Reconn
	(Emily) Reconn
Mitsubishi	Type 96 Reconn
Nakajima	Type 95 (Dave) Reconn
Nakajima	Type 96 Reconn
Sasebo	Type O (Pete) Reconn
Copy of Sikorsky S-42	Type 97 Reconn

Aviation's Foreign Airplane S

BRITISH AIRCRAFT

General			Power Plant					Performance								W	
ation or el No.	Type	Number of seats	Number and Make of engine	Total rated hp. ea.	At altitude, ft.	Fuel capacity (gal.)	Normal range (mi.)	High speed (m.p.h.)	At altitude, ft.	Cruising speed (m.p.h.)	At altitude, ft.	Stalling speed (m.p.h.)	Climb at sea level (ft. per min.)	Service ceiling (ft.)		Wing loading (lb. per sq. ft.)	Power loading (lb. per hp.)
ner	CML	3	2P&W	450	SL	140	980	202	SL	166	5,000	66	1,100	19,200		21.55	10.5
T	CML	5	2R-R	1,145	.....	715	2,200	225	18,500	215	15,000	.....	1,000	25,000		.....	.....
ort	CML	45	4Wr.	900	.....	670	1,310	210	7,000	170	7,000	.....	900	22,000		19.8	13
ner	CML	3	2A-S	450	.....	.....	790	202	5,000	158	.....	.....	720	19,000		19.5	12.9
ter IA Bomber	CML	6/7	2R-R Vultures	1,945	.....	.....	1,000	300*	.....	.....	.....	.....	.....	.....		.....	.....
nsport	CML	55	4R-R Merlin XX	1,260	12,250	2,000	3,000	300	.....	.....	.....	.....	.....	.....		.....	.....
r II Bomber	CML	7	4 Bristol	1,600	12,250	2,000	3,000*	300*	.....	.....	.....	.....	.....	.....		.....	.....
	CML	4	2 Bristol	890	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....
mber	CML	2	1Bristol	905	.....	.....	.....	225	6,500	144	15,000	.....	.....	20,200		.....	.....
	CML	2	1Bristol	905	.....	.....	.....	212	.....	.....	.....	.....	.....	.....		.....	.....
suit	CML	2	1Merlin XX	1,260	.....	.....	.....	314	17,500	.....	.....	.....	.....	.....		.....	.....
Bomber	CML	3	2Bristol	920	.....	.....	1,900	295	15,000	220	.....	.....	1,500	27,000		.....	.....
mber-Rec	CML	4	2Bristol	1,145	.....	.....	.....	275	15,000	.....	.....	.....	.....	.....		.....	.....
tack	CML	2	2Bristol	1,600	SL	550	1,300	350	14,000	.....	.....	.....	.....	.....		.....	.....
port	CML	...	2Bristol	980	.....	.....	2,230	192	6,500	160	10,000	.....	.....	25,000		.....	.....
T.-T	CML	25	2Bristol	930	.....	402	1,210	239	6,500	203	.....	.....	1,470	20,900		27	10.0
nsport	CML	34	4Gipsy	525	SL	440	1,041	.....	.....	210	11,000	.....	1,018	17,900		.....	.....
Bomber	CML	2/3	2R-R Merlin XX	1,280	12,250	447	2,000*	400*	.....	.....	.....	.....	.....	.....		.....	.....
nsport	CML	21	2Bristol	930	SL	402	1,210	239	6,500	200	10,000	.....	1,470	20,900		27	10.0
	CML	2	2Gipsy-Six-R	230	SL	.....	.....	235	SL	.....	.....	.....	.....	.....		.....	.....
Trainer	CML	2	1R-R	1,030	SL	212	1,000	233	20,000	200	.....	60	.....	25,000		26.6	10.4
Fighter	CML	2	1R-R	1,145	5,250	.....	1,000	300	.....	250	.....	.....	.....	.....		25.1	.....
Rec	OBFL	2	1N-H	395	.....	96	440	124	5,860	106	5,860	86	420	11,000		12.5	13.72
al Rec	OBFL	3	1Bristol	775	.....	.....	660	140	7,000	120	.....	.....	1,220	19,250		.....	.....
	CBFL	3	1Bristol	1,065	5,000	.....	700	190	6,500	.....	.....	.....	.....	20,000		.....	.....
mber	CML	4	2Bristol	1,000	.....	654	1,725	265	15,500	217	15,000	.....	980	22,700		28.1	9.77
Bomber	CML	7	4R-R	1,175	20,500	.....	3,000	300	.....	.....	.....	.....	.....	.....		.....	.....
Interceptor	CML	1	1R-R	1,030	16,000	.....	730	335	18,500	213	.....	.....	2,400	35,000		25.6	6.4
Pursuit	CML	1	1Napier	2,000	SL	.....	.....	400+	.....	.....	.....	105	.....	.....		.....	.....
ner	OML	2	1Gipsy	130	SL	21	.....	305	1,000	.....	.....	45	.....	18,000		.....	.....
r	CML	2	1R-R	720	SL	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....
o-Transport	CML	55	8R-R	1,750	16,000	.....	3,450	425	16,000	350	16,000	.....	1,500	.....		55.2	8.96
nsport	CML	...	1P&W	550	5,000	125	1,200	170	5,000	150	5,000	.....	714	22,000		.....	.....
al Rec	CMF	7	2Bristol	1,375	SL	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....
Naval Rec	CMF	6	4Bristol	1,010	SL	1,520	2,880	210	6,250	.....	.....	78	1,200	20,500		.....	.....
vy Bomber	CML	7	4Bristol	1,600	.....	.....	2,000	300	14,000	200	.....	.....	.....	.....		.....	.....
sport	CMF	...	4Bristol	1,380	SL	3,470	3,200	213	5,500	180	5,000	80	.....	.....		.....	.....
Bomber	CML	5	2Bristol	1,370	.....	.....	1,550+	263	14,000	.....	.....	.....	.....	.....		.....	.....
rceptor	CML	1	1R-R	1,030	16,250	85	.....	367	18,500	.....	.....	65	2,300	.....		.....	.....
wing	CML	1	1R-R	1,150	.....	.....	.....	369+	19,000	.....	.....	.....	.....	.....		.....	.....
erceptor	CML	1	1R-R 61	.....	.....	.....	.....	400+	.....	.....	.....	.....	.....	.....		.....	.....
Army Co-op	CML	2	1Bristol	905	.....	95	600	230	10,000	150	.....	55	1,600	26,000		.....	.....
	CML	1	2R-R Merlin	850	.....	.....	.....	400*	.....	.....	.....	.....	.....	.....		.....	.....

GERMAN AIRCRAFT

r-Seaplane	CBFL	2	1B.M.W.	880	.....	900	530	187	9,840	150	.....	56.5	.....	23,945		16.56	9.02
ter-Seaplane	CMF	2	1Bramo Fafnir	920	.....	.....	670	193	13,000	158	13,000	.....	980	23,000		20	8.9
naissance	CMF	5	3Junkers Jumo	600	.....	.....	1,490	171	.....	146	.....	62	729	16,000		21.6	13.33
ervation	CMF	5	4Junkers Jumo	600	SL	1,961	3,230	201.8	.....	167.6	.....	68.3	550	14,100		27.67	16.1
do Bomber	CML	4	2B.M.W.	880	.....	.....	1,550	198.7	13,000	183	.....	68.3	850	23,000		19.88	11.66
naissance	CML	2	1Bramo Fafnir	1,000	.....	.....	.....	220	17,000	.....	.....	.....	.....	.....		.....	.....
	CML	30	4B.M.W.	880	.....	1,440	2,732	248	13,000	217	.....	62	1,190	22,305		25.6	10.12
	CMF	...	6B.M.W.	1,000	.....	640	.....	199	9,840	130*	.....	.....	.....	.....		.....	.....
ann Trainer	CML	2	1Hirth H.M.	105	.....	25	500	133	.....	121	.....	43	623	16,400		11.27	7.14
per	CML	4	2Bramo	1,000	SL	.....	745	275	16,400	248	14,200	72	.....	29,600		30	.....
r-Rec	CMF	5	4Junkers Jumo	750	.....	.....	5,600	208	1,000	193	SL	.....	.....	.....		.....	.....
er	CML	3	2D.B.	1,175	.....	568	1,500	312	16,400	264	.....	68	.....	24,230		.....	.....
ber	CML	4	2B.M.W.	2,000	SL	.....	1,500	324	18,500	255	.....	.....	638	25,000		.....	.....
ation	CML	3	1Argus	240	.....	42	.....	108	.....	.....	.....	31	945	18,3' 0		9.94	11.6
ation	CBL	2	1D-B	1,150	.....	.....	930	202	12,000	.....	.....	62	.....	26,900		.....	.....
t	CML	2	2D-B	1,400	14,760	.....	650	395	19,685	.....	.....	.....	2,650	38,700		44.5	.....
vation	CML	3-5	2Hirth Argus	450	14,760	.....	.....	221	8,530	.....	.....	.....	1,640	27,5o0		18.3	.....
	CML	1	1B.M.W.	1,605	17,000	138	520	390	20,000	275	.....	100	3,000	38,000		42.26	5.43
r	CML	1	1D-B	1,000	14,760	110	550	370	19,000	295	.....	.....	2,750	34,500		28.	.....
rier Bomber	CML	6	4B.M.W.	1,320	SL	2,112	3,000	279	9,500	220	.....	.....	.....	28,000		.....	.....
r	CML	1	1D-B	1,070	.....	.....	715	358	12,300	282	13,120	90	3,200	31,000		.....	.....
r	CML	1	1D-B	1,300	.....	.....	.....	380	19,000	.....	.....	.....	.....	.....		.....	.....
Rec	CMFL	3	2B.M.W.	880	.....	.....	1,305	217	11,150	186	11,150	71.4	.....	21,320		.....	.....
er	CML	5	4B.M.W.	1,600	.....	1,575	7,040	280	19,000	180	.....	.....	.....	36,000		.....	.....
H Bomber	CML	6	2Junkers Jumo	1,200	12,300	1,056	2,140	274	12,800	230	.....	.....	890	24,100		.....	.....
	CML	2	1B.M.W.	870	8,200	135	685	221	9,840	186	13,120	.....	1,800	28,000		20	7.84
r-Bomber	CML	1	2Gnome Rhone	650	.....	.....	.....	285	SL	.....	.....	.....	.....	.....		.....	.....
	CML	19	3B.M.W.	760	.....	800	1,000	189	4,590	175	9,840	65.8	.....	.....		19.47	10.14
Bomber	CML	2	1Junkers Jumo	1,200	13,800	110	360	250	13,800	.....	.....	.....	.....	27,890		.....	.....
ber	CML	4	2Junkers Jumo	1,200	.....	.....	2,520	317	15,600	264	.....	87	.....	29,800		.....	.....
mber	CML	2	2Junkers Jumo	1,000	20,000	.....	1,500	275	30,000	.....	.....	.....	.....	42,600		25.4	.....
	CML	43	4B.M.W.	880	.....	.....	1,305	236	3,610	198	9,840	.....	.....	18,040		25.6	15.25
	CML	54	4 Bramo Fafnir	1,000	.....	.....	1,491	250	.....	.....	.....	.....	.....	20,000		.....	.....
vation	CML	4	.....	270	.....	.....	620	197	SL	188	.....	.....	.....	20,340		.....	.....
hter	CML	1	1D-B	1,600	.....	.....	420	390	18,500	298	.....	75	3,100	36,000		31.4	4.8
ghter	CML	3	2D-B	1,200	.....	400	1,500	365	16,400	304	16,400	.....	.....	35,000		.....	.....
er-Bomber	CML	2	2D-B	1,400	14,000	550	1,700	368	20,000	.....	.....	.....	.....	28,500		60	.....
	CML	130	6Gnome-Rhone	750	.....	.....	500	170	.....	110	.....	.....	.....	.....		.....	.....
	.....	.....	.....	.....	.....	.....	.....	400	Development of Me. 210								

JAPANESE AIRCRAFT

Fighter	CML	1	1Nakajima 12	950	13,750	225	895	326	16,000	.....	.....	70	3000+	38,500		20.2	.....
Fighter	CML	1	1Nakajima 21	1,060	15,000	228	.....	350	17,000	.....	.....	75	3000+	40,200		.....	.....
Fighter	CMF	1	1Nakajima 12	950	13,750	225	895	279	15,200	.....	.....	.....	.....	36,500		25.4	.....
e) Fighter	OML	1	1Kinsei	730	9,000	134	440	250	9,000	217	9,000	.....	833	31,000		.....	.....
) Fighter	CML	1	1Hikari	800	13,000	80	460	280	13,000	230	.....	.....	.....	33,000		.....	.....
) Fighter	CML	1	1Type 99	950	15,000	149	.....	315	15,000	.....	.....	.....	.....	35,000		.....	.....
) Fighter	CML	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....
Fighter-Bomb.	CML	3	1Showa	850	5,800	246	950	225	6,800	186	12,000	.....	.....	26,500		.....	.....
Dive-Bomber	CML	2	1Kinsei 44	1,075	6,500	271	875	236	6,200	.....	.....	.....	.....	23,000		.....	.....
Torpedo-Bomb.	OBFL	2	1Kawanishi	650	.....	.....	617	.....	.....	.....	.....	.....	.....	25,800		.....	.....
Torpedo-Bomb.	OBL	3	1Kinsei	730	.....	280	.....	225	1,500	.....	.....	.....	.....	20,400		.....	.....
) Torpedo-Bomb.	CML	2-3	1Saka II	1,000	.....	.....	980	230	10,000	190	.....	.....	.....	24,000		.....	.....
Bomber	CML	2	Kotobuki	600	.....	.....	.....	217	.....	.....	.....	.....	.....	25,240		.....	.....
Bomber	CML	7	2Kinsei	1,060	6,500	498	1,220	225	7,000	190	10,000	.....	.....	28,000		.....	.....
1) Bomber	CML	7	2Kinsei	870	10,000	650	1,200	230	10,000	.....	.....	.....	.....	22,000		.....	.....
2) Bomber	CML	5	2Mitsubishi	1,000	.....	.....	1,000	264	13,000	212	10,000	.....	.....	23,500		.....	.....
Bomber	CML	2	1Mitsubishi	800	.....	450	1,490	310	.....	.....	.....	.....	.....	.....		.....	.....
Bomber	CML	3	1Mitsubishi	900	9,000	168	260	250	11,000	208	15,000	.....	.....	25,000		.....	.....
r) Bomber	CML	7-8	2Kasei 15	1,050	.....	756	1,800	288	13,000	.....	.....	.....	.....	30,000		.....	.....
Bomber	CML	7	2Mitsubishi	900	.....	.....	2,484	230	.....	150	.....	.....	.....	.....		.....	.....
ah) Reconn-Bomb.	CML	2	2	1,060	.....	.....	.....	324	17,000	.....	.....	.....	3,000*	.....		.....	.....
Reconn-Bomb.	CML	2	1Kawasaki	850	.....	175	490	236	13,000	.....	.....	.....	.....	25,000		.....	.....
kaze) Reconn	CML	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....
Reconn-Bomb.	CML	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....
Transport	CML	15	2Mitsubishi	520	SL	.....	1,240	266	.....	193	7,000	75	.....	23,000		24.2	8.8
Transport	CML	10	2	900	.....	.....	.....	230	.....	.....	.....	.....	.....	29,520		.....	.....
Bomb.-Transpt.	CML	5	2Mitsubishi	900	.....	.....	.....	.....	.....	161	.....	.....	.....	.....		.....	.....
Reconn.	CMF	2	1	.....	.....	.....	.....	216	7,500	.....	.....	.....	.....	24,400		.....	.....
Reconn	OBFL	2	1Aichi	770	13,000	144	410	180	13,000	155	13,000	.....	.....	30,000		.....	.....
s) Reconn	CMF	8	4Kinsei 42	900	13,000	1,747	1,900	160	13,000	165	6,000	.....	.....	26,000		.....	.....
y) Reconn	CMF	...	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....
Reconn	CBF	6	3Mitsubishi	900	10,000	1,800	1,475	145	10,000	125	10,000	.....	.....	13,000		.....	.....
e) Reconn	OBFL	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		.....	.....
Reconn	MFL	2	1Nakajima	750	.....	.....	475	220	.....	.....	.....	.....	.....	25,700		.....	.....
Reconn	OBFL	2	1Sakae 12	950	13,750	139	895	280	16,000	.....	.....	.....	.....	26,000		.....	.....
Reconn	CMF	...	4	.....	.....	.....	.....	.....	.....	180	.....	.....	.....	.....		.....	.....

plane Specifications

Although the data given are from reliable sources and have been checked from every possible angle, Aviation cannot assume responsibility for the figures given.

RCRAFT

Performance			Weights				Dimensions			Area	Wings			Landing Gear			Fuselage or Hull †
Maximum speed (m.p.h.)	Climb at sea level (ft. per min.)	Service ceiling (ft.)	Wing loading (lb. per sq. ft.)	Power loading (lb. per hp.)	Weight empty (lb.)	Gross weight (lb.)	Span	Length overall	Height overall	Wing (including ailerons)	Spars	Ribs	Covering material	Type	Tread (in.)	Tail unit	
66	1,100	19,200	21.55	10.5	5,322	7,500	53′ 4″	34′ 6″	11′ 1″	348	W.	Ply.	Ply.	Re.	...	Wh.	Semi-Mo.
...	1,000	25,000	...	...	17,000	27,900	84′	72′ 6″	15′	1232	1Al. Box	Al.	Al. Fab.	Re.	...	Wh.	Me. Mo.
...	900	22,000	19.8	13	34,000	48,500	123′	114′	23′	2450	1Me. Box	Me.	Me. Fab.	Re.	...	Wh.	Me. Mo.
...	720	19,000	19.5	12.91	4,800	7,500	56′ 6″	42′ 3″	13′ 1″	410	2Sp. Box	Sp.	Pl.	Re.	...	Wh.	Me. Fab.
...	...	...	...	...	...	50,000	70′	19′ 6″	20′	1131	2Me.	Al.	Al.	Re.	...	Wh.	Me. Mo.
...	...	...	...	...	...	...	102′	78′ 6″	20′	1297	2Me.	.....	.....	...	...	.....	.....
...	...	...	...	...	35,000	63,000	102′	69′ 4″	20′	1297	2Me.	.....	.....	...	...	.....	.....
...	...	...	...	...	...	...	59′	51′ 1″	14′ 7″	.....	2Me.	Al.	Al.	Re.	...	Wh.	Me. Mo.
...	...	20,200	...	...	5,490	8,228	46′ 2″	35′ 7″	14′ 2″	312	Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	...	...	...	...	...	...	46′	35′ 7″	12′ 1″	310	Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	...	...	...	...	...	7,500	39′ 6″	35′ 4″	11′ 4″	250	Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	1,500	27,000	...	...	8,250	14,400	56′ 4″	42′ 9″	9′ 10″	469	SS.	Al.	Al.	Re.	...	Wh.	Me. Mo.
...	...	...	...	...	...	...	58′ 6″	44′ 7″	14′ 3″	.....	Me.	Me.	Me.	Re.	...	Wh.	Me.
...	...	...	...	...	13,800	21,000	57′ 10″	41′ 4″	15′ 10″	.....	Me.	Me.	Me.	Re.	...	Wh.	Me.
...	...	25,000	...	...	...	...	95′ 6″	69′ 3″	19′ 6″	1340	.....	.....	.....	...	...	.....	.....
...	1,470	20,900	27	10.05	12,020	17,600	70′	51′ 10″	12′	651	Me.	Me.	Me.	Re.	...	Wh.	Me. St. Sn.
...	1,018	17,900	...	...	...	...	105′	71′ 6″	22′ 3″	1078	Sp. Box	Sp. Ply.	Ply.	Re.	...	Wh.	Mo. Ply.
...	...	...	...	...	...	20,000	54′ 2″	40′ 9″	17′ 3″	420	W.	W.	Ply.	Re.	...	Wh.	W. Mo.
...	1,470	20,900	27	10.05	12,020	17,600	70′	51′ 10″	15′ 3″	651	Al.	Al.	Fab. Al.	Re.	...	Wh.	Me. St. Sn.
...	...	...	...	...	...	8,500	44′	29′	9′	.....	.....	.....	.....	...	...	.....	.....
60	.....	25,000	26.6	10.4	6,647	10,792	54′	40′ 4″	15′ 6″	422	Me.	Me.	Me.	Re.	...	Wh.	Me. St. Sn.
...	...	...	25.1	...	6,338	8,688	47′ 4″	...	14′ 1″	346	Me.	Me.	Me.	Re.	...	Wh.	Me.
86	420	11,000	12.5	13.72	3,805	5,420	40′	35′ 5″	12′ 1″	434	Me.	Me.	Fab.	Fl.	...	.....	Me. Mo.
...	1,220	19,250	...	...	4,500	7,720	45′ 6″	40′ 11″	14′ 7″	542	Me.	Me.	Fab.	Fl.	...	.....	Me. Fab.
...	...	20,000	...	...	...	...	50′	39′ 10″	14′ 2″	600	Me.	Me.	Fab.	Fx.	...	Wh.	Me.
...	980	22,700	28.1	9.77	11,780	18,756	69′ 2″	53′ 7″	14′ 11″	668	Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	...	...	...	...	36,000	60,000	98′ 10″	70′ 1″	22′	1250	Me.	Me.	Me.	Re.	...	Wh.	Me.
...	2,400	35,000	25.6	6.4	4,911	6,600	40′	31′	13′ 1″	257.5	Me.	Me.	Me.	Re.	...	Wh.	Me. W. Fab.
105	.....	...	...	...	...	...	41′ 7″	31′ 11″	15′ 3″	276	Al.	Me.	Me.	Re.	...	Wh.	Me. Mo.
45	.....	18,000	...	...	1,250	1,863	33′ 10″	25′ 3″	6′ 8″	176	W. Box	W. Box	Ply.	Fx.	...	Wh.	Ply. Sp.
...	...	...	...	...	4,245	5,573	39′	30′ 8″	10′	217	W.	W.	Ply.	Re.	...	Wh.	Semi-Mo.
...	1,500	.....	55.2	8.96	65,000	130,000	150′	110′	...	2350	.....	.....	.....	...	...	.....	.....
...	714	22,000	...	...	3,816	7,450	51′ 6″	32′	10′ 3″	325	W.	W.	Fab.	Fx.	...	Wh.	Wl. S. T. Fab
...	...	...	...	...	...	...	81′	63′	20′	.....	Me.	Me.	Me.	.....	...	.....	Me.
78	1,200	20,500	...	...	28,290	45,700	112′ 9″	87′ 4″	32′ 11″	1487	4Me. Box	Me.	Me.	.....	...	.....	Me.
...	...	...	...	...	46,000	70,000	99′ 1″	87′ 3″	22′ 9″	1460	.....	.....	.....	Re.	...	Wh.	.....
80	.....	...	...	...	37,700	74,500	134′ 4″	103′ 2″	37′ 7″	2390	Me.	Me.	Me.	.....	...	.....	Me.
...	...	...	...	...	...	24,850	86′ 2″	61′ 3″	17′ 5″	750	Me.	Me.	Fab.	Re.	...	Wh.	Me. Fab.
...	...	...	...	...	...	5,850	36′ 10″	29′ 11″	11′ 5″	242	Me. Box	Me.	Me.	Re.	...	Wh.	Me. Mo.
65	2,300	...	...	...	...	...	32′ 2″	30′	11′ 5″	232	Me. Box	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	...	...	...	...	...	...	36′ 10″	31′	11′ 5″	2x2	.....	.....	.....	...	...	.....	.....
55	1,600	26,000	...	...	4,065	5,920	50′	30′ 6″	14′ 6″	260	Me.	Me.	Fab.	Fx.	...	Wh.	Wl. W. S. T. Fab
...	...	...	...	...	...	...	45′	32′ 3″	14′ 6″	.....	.....	.....	.....	...	...	.....	.....

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6.5	.....	23,945	16.56	9.02	5,588	8,074	41′	36′ 5″	17′	488.5	Al.	Al.	Al. Fab.	Fl.	...	.....	Me. Mo.
...	980	23,000	20	8.9	6,580	8,200	49′ 6″	38′ 6″	16′ 5″	408	Me.	Me.	Me. Fab.	Fl.	...	.....	Me. Mo.
2	729	16,000	21.6	13.33	17,820	26,180	88′ 7″	65′ 3″	.....	1204	.....	.....	.....	Fl.	...	.....	Me.
8.3	550	14,100	27.67	10.1	22,902	38,610	80′ 7″	64′ 6″	14′ 7″	1399	Tube Me.	Al.	Al. Fab.	Fl.	...	.....	Me. Mo.
8.3	850	23,000	19.88	11.66	13,860	18,700	68′ 10″	57′ 9″	.....	941.5	Tube Me.	Al.	Al. Fab.	Fl.	...	.....	Me. Mo.
...	...	...	...	...	...	9,700	66′	49′	.....	.....	.....	.....	.....	...	...	.....	.....
2	1,190	22,305	25.6	10.12	23,000	35,640	96′ 9″	63′ 11″	15′ 6″	1399	Me.	Me.	Me.	Re.	...	.....	Me. Mo.
...	...	...	...	...	...	100,000	150′	112′	41′	2655	.....	.....	.....	...	...	.....	.....
3	623	16,400	11.27	7.14	1,056	1,650	34′ 9″	25′ 5″	6′ 5″	145.3	W.	W.	Ply.	Fx.	...	Wh.	Me. Mo.
2	.....	29,600	30	...	11,484	19,481	59′	53′ 5″	15′ 9″	592	Al.	Al. Tube	Al.	Re.	...	.....	Me. Mo.
...	.....	...	...	...	22,450	50,000	98′ 6″	80′ 6″	22′ 6″	1290	.....	.....	.....	...	...	.....	.....
8	.....	24,230	...	...	11,625	18,960	59′ 1″	53′ 6″	15′ 9″	592	Al.	Al. Tube	Al.	Re.	...	Wh.	Me. Mo.
...	638	25,000	...	...	19,000	34,000	62′ 5″	56′ 6″	.....	610	Al.	Al.	Al.	Re.	...	Wh.	Me. Mo.
1	945	18,3 0	9.94	11.6	1,892	2,772	46′ 9″	32′ 6″	10′	279.7	W.	W.	Fab.	Fx.	...	Wh.	Wl. St. Fab.
2	...	26,900	...	...	6,170	9,920	44′ 3″	37′ 5″	.....	489.8	Me.	Me.	Fab.	Fx.	...	Wh.	Me.
...	2,650	38,700	44.5	...	...	14,000	51′	33′	.....	315	Me.	Me.	.....	Re.	...	Wh.	Me. Mo.
...	1,640	27,500	18.3	...	5,920	7,480	60′ 4″	39′ 4″	.....	409	Me.	Me.	Me.	Re.	...	Wh.	Me.
0	3,000	38,000	42.26	5.43	6,240	9,200	34′ 5″	29′ 4″	.....	203	Me.	Me.	Me.	Re.	...	Re. W.	Me. Mo.
...	2,750	34,500	28.	...	4,700	7,000	41′	31′ 6″	.....	256	Me.	Me.	.....	Re.	...	Wh.	Me.
...	...	28,000	...	...	28,700	48,500	108′	78′ 2″	20′	1291	Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
0	3,200	31,000	...	...	4,188	5,740	29′ 10″	29′ 6″	12′ 1″	183	Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	...	...	...	...	...	...	30′ 10″	26′ 10″	8′ 3″	156	Me.	Me.	St. Sn. Me.	Re.	...	Wh.	Me. Mo.
1.4	.....	21,320	...	...	11,670	20,020	75′ 10″	57′	23′ 4″	946	Me.	Me.	Me.	Fl.	...	.....	Me. Mo.
...	.....	36,000	...	...	35,000	71,600	103′ 4″	67′ 3″	18′ 2″	1092	.....	.....	.....	...	...	.....	.....
...	890	24,100	...	...	14,400	25,000	74′ 3″	54′ 6″	13′ 9″	942	Me.	Me.	Me.	Re.	...	Wh.	Me.
...	1,800	28,000	20	7.84	4,480	6,820	47′ 6″	35′ 7″	12′ 3″	340	Me.	Me.	Al. Fab.	Fx.	...	Wh.	Me. Mo.
...	...	...	...	...	...	9,000	44′ 6″	33′ 3″	...	317	.....	.....	.....	...	...	.....	.....
5.8	.....	...	19.47	10.14	15,400	23,200	95′ 11″	62′	14′ 10″	1190	Al. Tube	Al.	Al.	Fx.	...	Wh.	Me.
...	.....	27,890	...	...	6,100	9,300	45′ 4″	35′ 6″	12′ 9″	344	Al.	Al.	Al.	Fx.	...	Wh.	Me.
7	.....	29,800	...	...	16,847	27,060	60′ 3″	47′ 1″	15′ 5″	515	Al.	Al.	Al.	Re.	...	Wh.	Me. Mo.
...	.....	42,600	25.4	...	...	22,900	84′	53′	15′ 8″	.....	.....	.....	.....	...	...	.....	.....
...	.....	18,040	25.6	15.25	35,200	50,600	114′ 10″	86′ 3″	24′ 11″	1980	Al. Tube	Al.	Al.	Re.	...	Wh.	Me. Mo.
...	.....	20,000	...	...	...	55,000	123′	86′ 3″	21′ 3″	.....	.....	.....	.....	...	...	.....	.....
...	.....	20,340	...	...	...	...	34′ 5″	27′ 2″	7′ 6″	172	.....	.....	.....	...	...	.....	.....
5	3,100	36,000	31.4	4.8	4,180	6,820	32′ 8″	29′ 8″	8′ 6″	176.5	1Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	.....	35,000	...	...	9,900	15,300	53′ 5″	40′ 6″	10′ 9″	414	Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	.....	28,500	60	...	...	18,000	53′ 6″	36′ 4″	.....	355	Me.	Me.	.....	Re.	...	Wh.	Me. Mo.
...	.....	...	...	...	34,000	65,000	181′	93′ 4″	24′	2700	.....	.....	.....	...	...	.....	.....

RCRAFT

0	3000+	38,500	20.2	.....	3,718	5,140	39′ 5″	29′ 8″	9′	248	Me.	Me.	Me.	Re.	...	Re.	.....
5	3000+	40,200	...	.....	3,913	5,750	36′ 6″	29′ 8″	9′	238	Me.	Me.	Me.	Re.	...	Re.	.....
...	.....	36,500	25.4	.....	4,145	5,920	39′ 5″	33′ 2″	14′	248	Me.	Me.	Me.	Fl.	...	.....	.....
...	833	31,000	...	.....	3,150	4,300	36′	25′	9′ 9″	140	.....	.....	.....	Fx.	...	Sk.	.....
...	.....	33,000	...	.....	3,250	4,400	35′ 7″	24′ 4″	8′	170	.....	.....	.....	...	...	.....	.....
...	.....	35,000	...	.....	3,385	4,780	37′ 7″	29′ 2″	.....	233	.....	.....	.....	Re.	...	Fx.	.....
...	.....	...	...	.....	...	...	...	...	...	.....	.....	.....	.....	...	...	.....	.....
...	.....	26,500	...	.....	6,250	9,700	49′ 11″	37′ 6″	9′ 11″	335	.....	.....	.....	Re.	...	.....	.....
...	.....	23,000	...	.....	5,900	8,070	48′	37′	.....	390	.....	.....	.....	Fx.	...	Fx.	.....
...	.....	25,800	...	.....	...	...	...	...	...	.....	.....	.....	.....	...	...	.....	.....
...	.....	20,400	...	.....	4,830	8,392	51′ 2″	34′ 5″	...	415	.....	.....	.....	...	...	.....	.....
...	.....	24,000	...	.....	4,830	7,230	52′	34′	10′	370	.....	.....	.....	Re.	...	Fx.	.....
...	.....	25,240	...	.....	...	...	39′ 8″	28′	11′ 4″	.....	.....	.....	.....	...	...	.....	.....
...	.....	28,000	...	.....	10,610	18,500	82′	54′	12′ 6″	750	.....	.....	.....	Re.2	...	Wh.	.....
...	.....	22,000	...	.....	...	...	72′	52′	12′	675	Me.	Me.	Me.	Re.	...	Wh.	.....
...	.....	23,500	...	.....	...	20,500	73′	52′	12′	.....	Me.	Me.	Me.	Re.	...	Wh.	.....
...	.....	...	...	.....	...	5,060	39′ 4″	27′ 11″	11′ 6″	258	Me.	Me.	Me.	Fx.	...	Wh.	Me. Mo.
...	.....	25,000	...	.....	5,170	7,800	46′	29′ 4″	11′ 9″	290	.....	.....	.....	Fx.	...	Wh.	.....
...	.....	30,000	...	.....	14,722	20,442	81′ 10″	66′ 3″	18′*	.....	.....	.....	.....	Re.	...	Wh.	.....
...	.....	...	...	.....	...	10,450	72′ 2″	50′ 9″	11′ 11″	675	Me.	Me.	Me.	Re.	...	Wh.	Me. Mo.
...	3,000*	...	...	.....	...	...	...	...	...	.....	.....	.....	.....	...	...	.....	.....
...	.....	25,000	...	.....	4,500	7,000	47′ 9″	.....	.....	.....	.....	.....	.....	...	...	.....	.....
...	.....	...	...	.....	...	...	...	...	...	.....	.....	.....	.....	...	...	.....	.....
5	.....	23,000	24.2	8.	11,900	18,300	74′	52′ 9″	16′ 2″	755	Me.	Me.	Me.	Re.	...	Wh.	.....
...	.....	29,520	...	.....	...	...	...	...	...	.....	.....	.....	.....	Re.	...	Wh.	.....
...	.....	...	...	.....	...	11,000	82′	52′ 6″	12′ 1″	.....	.....	.....	.....	Re.	...	.....	.....
...	.....	24,400	...	.....	...	...	47′ 6″	35′ 4″	...	.....	.....	.....	.....	Fl.	...	.....	.....
...	.....	30,000	...	.....	3,910	5,630	42′ 7″	32′ 6″	13′ 1″	430	.....	.....	.....	Fl.	...	.....	.....
...	.....	26,000	...	.....	25,000	44,092	131′	82′	20′ 6″	1400	.....	.....	.....	Fl.	...	.....	.....
...	.....	...	...	.....	...	...	118′	91′	...	.....	.....	.....	.....	...	...	.....	.....
...	.....	13,000	...	.....	21,280	38,750	96′ 9″	70′	26′ 3″	2504	.....	.....	.....	...	...	.....	.....
...	.....	...	...	.....	...	...	36′ 2″	27′ 11″	13′ 2″	.....	.....	.....	.....	Fl.	...	.....	.....
...	.....	25,700	...	.....	...	...	...	...	...	.....	.....	.....	.....	Fl.	...	.....	.....
...	.....	26,000	...	.....	4,192	5,623	37′	26′ 0″	12′ 6″	.....	.....	.....	.....	Fl.	...	.....	.....

Key to Abbreviations

* —Approximate
A —Amphibian
Al —Aluminum alloy
B —Biplane
Box —Box spar
C —Closed
Cy —Cyclone
F —Flying boat
Fab —Fabric
Fl —Floats
Fx —Fixed
Hyd —Hydraulic
Id —Inverted
L —Landplane
Lmd —Laminated
M —Monoplane
Me —Metal
Mech—Mechanical
Mo —Monocoque
O —Open
Ol —Oleo
Ply —Plywood
Pn —Pneumatic
P&W—Pratt & Whit
Re —Retractable
S —Steel
SL —Sea level
Sol —Solid
Sp —Spruce
Spr —Spring
SS —Stainless Steel
T —Tubing
TT —Troop Transp
Trs —Truss
Tri —Tricycle
W —Wood
Wl —Welded
Wh —Wheel
Wr —Wright

Japanese aircraft t… numbers are set accor… to the year of manuf… ture; thus a type 99 wo… have been built in the … year 2599 or, according … our calendar, 1939. … many cases several ma… facturers build the sa… type — sometimes w… variations — with … principal or original p… ducer being listed in … table as the manufactu… The figures given are … official but to the best … our knowledge are … most accurate and co… prehensive yet presen…

AVIATION'S
Russian Aircraft Specifications

General			Power Plant				Performance							Weights				Dimensions			Area
Designation or Model No.	Type	Number of seats	Number and Make of Engine	Total rated hp. ea.	At altitude, ft.	Normal range (mi.)	High speed (m.p.h.)	At altitude, ft.	Cruising speed (m.p.h.)	At altitude, ft.	Stalling speed (m.p.h.)	Climb at sea level (ft. per min.)	Service ceiling (ft.)	Wing loading (lb. per sq. ft.)	Power loading (lb. per hp.)	Weight empty	Gross weight (lb.)	Span	Length overall	Height overall	Wing (including ailerons)
... Fighter	OBL	2	1 M-63	1,000	.....	530	240	.....	.....	.....	.....	.....	31,820	.....	.....	.....	4,290	35′ 3″	25′ 7″	.....	.....
... Fighter	OBL	1	1 M-25	750	.....	465	223	.....	.....	.....	.....	.....	25,500	.....	.....	.....	4,140	33′ 5″	20′ 10″	.....	.....
... Fighter	OBL	1	1 M-63	1,000	.....	500	217	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	33′ 5″	20′ 10″	.....	.....
... Fighter	OML	1	1 M-63	1,000	.....	465	280	.....	225	.....	.....	.....	28,500	.....	.....	.....	3,190	29′ 2″	20′ 4″	.....	.....
... Fighter	OML	1	1 M-88	1,100	.....	.....	300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31′ 3″	23′	.....	.....
... Fighter	CML	1	1 M-100	1,100	.....	600+	310	.....	273	.....	.....	.....	36,000	.....	.....	.....	4,230	33′ 1″	24′ 2″	.....	.....
... Fighter	CML	1	1 M-100	1,100	.....	.....	400	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Fighter	CML	1	1 Toupolev	1,300	.....	.....	378	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Fighter	CML	1	2 Toupolev	1,300	.....	.....	400	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Fighter	CML	1	1	1,600	.....	.....	370	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,400	31′ 9.5″	28′ 7″	.....	.....
... Fighter	OBF	1	1 M-17 BMW	680	.....	310	150	.....	.....	.....	.....	.....	23,900	.....	.....	.....	2,900	37′ 4″	23′ 10″	.....	.....
... Fighter	CML	1	1 AM-35a	1,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	37′ 6″	31′ 2″	.....	.....
... Fighter	CML	1	1 M-105p	1,100	.....	.....	345	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,000	36′	30′	.....	.....
... Fighter-Bomber	CML	1	1 M-63	1,000	.....	.....	248	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	32′ 10″	20′ 2″	.....	.....
... Fighter-Bomber	CML	1	1 M-105p	1,100	SL	400	348	16,500	279	16,400	87	2,000	30,000	37.2	6.37	5,770	7,040	31′ 9.5″	29′ 5″	8′ 4″	188
... Fighter-Bomber	CML	1	1 AM-35A	1,250	19,680	500	380	21,000	.....	.....	.....	.....	.....	.....	.....	.....	6,200	37′ 6″	31′ 2″	.....	.....
... Fighter-Bomber	CML	1	1 Toupolev	1,300	.....	.....	400	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,000	38′	32′	10′	281
... Fighter-Bomber	CML	1	1 M-105p	1,100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,000	36′	30′	.....	.....
... Fighter-Bomber	CML	2	1 M-88	1,100	.....	.....	275	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Attack-Bomber	CML	3	2 M-105	1,100	.....	500	280	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000	70′ 6″	40′	.....	.....
... Attack-Bomber	CML	1	1 AM-38	1,300	.....	.....	280	13,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	49′ 2″	38′ 6″	10′ 9″	.....
... Attack-Bomber	CML	2	1 AM-38	1,300	.....	.....	270	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49′ 2″	38′ 6″	.....	.....
... Attack-Bomber	CMF	5	2 M-17	680	.....	935	120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	94′ 1″	.....	.....	.....
... Medium Bomber	CML	3	2 M-85	1,000	.....	2,500	240	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Medium Bomber	CML	3–4	2 M-87b	950	.....	2,500	279	10,000	.....	.....	.....	.....	.....	.....	.....	.....	30,000	70′ 2″	46′ 10″	.....	.....
... Medium Bomber	CML	3–4	2 M-88	1,100	.....	2,500	270	16,000	186	.....	.....	.....	27,000	.....	.....	.....	33,000	70′ 2″	47′ 6″	.....	.....
... Medium Bomber	CML	3	2 M-25	630	.....	.....	217	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	70′ 6″	40′	.....	.....
... Medium Bomber	CML	3	2 M-63	1,000	.....	500	274	.....	.....	.....	.....	.....	.....	.....	.....	.....	14,300	70′ 6″	40′	.....	.....
... Medium Bomber	CML	3	2 M-103	950	.....	500	279	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,000	70′ 6″	41′ 6″	.....	.....
... Medium Bomber	CML	3	2 M-12 H-S	950	.....	550+	280	.....	220	14,400	.....	.....	.....	.....	.....	.....	.....	66′	41′ 6″	.....	.....
... Medium Bomber	CML	3	2 M-105	1,100	.....	.....	280+	.....	220+	.....	.....	.....	.....	.....	.....	.....	.....	70′ 6″	40′	.....	.....
... Medium Bomber	CML	4–5	2 M-17 BMW	680	.....	620	128	.....	.....	.....	.....	.....	17,500	.....	.....	.....	17,440	94′ 1″	59′	.....	.....
... Medium Bomber	CML	5	2 M-85	1,000	.....	.....	310	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Heavy Bomber	CML	8	4 M-34	830	.....	620	155	.....	.....	.....	.....	.....	16,400	.....	.....	.....	33,000	.....	.....	.....	.....
... Heavy Bomber	CML	8	4 M-100 H-S	1,100	.....	1,200	230	.....	.....	.....	.....	.....	26,000	.....	.....	.....	50,000	120′	.....	.....	.....
... Heavy Bomber	CML	11	4 AM-38	1,300	.....	2,500	280	25,000	210	.....	.....	.....	25,000	.....	.....	50,000	49,280	128′	75′	.....	.....
... Bomber	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Reconn-Bomber	CML	3–4	2 M-105	1,300	.....	.....	310	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60′	45′ 6″	13′	592
... Reconn-Bomber	CML	4	2 M-103	1,100	.....	.....	310	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	56′ 5″	39′ 4.5″	.....	.....
... Reconn-Bomber	CML	3	2 M-105	1,100	.....	.....	315	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Reconn-Bomber	CML	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Reconnaissance	CML	3	1 AM-34r	1,000	.....	6,000	150	.....	.....	.....	.....	.....	.....	.....	.....	.....	24,750	111′ 6″	43′ 11″	.....	.....
... Reconnaissance	OBL	2	1 M-34	830	.....	500	175	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Reconnaissance	OBL	2	1 M-22	480	.....	425	140	.....	.....	.....	.....	.....	19,350	.....	.....	.....	5,280	42′ 6″	31′ 2″	.....	.....
... Reconnaissance	OBL	2	1 M-17 BMW	680	.....	620	140	.....	100	.....	.....	.....	22,900	.....	.....	.....	6,150	50′ 9″	34′ 7″	.....	.....
... Reconnaissance	CML	3	2 M-17 BMW	680	.....	550	170	.....	.....	.....	.....	.....	22,900	.....	.....	.....	.....	41′ 3.5″	.....	.....	.....
... Transport	CML	8	3 M-26	900	.....	550	130	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,000	77′ 10″	55′ 10″	.....	.....
... Transport	CML	12	5 M-22	480	.....	725	135	.....	.....	.....	.....	.....	.....	.....	.....	.....	38,200	132′ 6″	87′	.....	.....
... Transport	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
K-5. Transport	CML	2	1 M-17	680	.....	.....	123	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,716	67′ 2.5″	51′ 6″	.....	.....
... Transport	CML	10	6 M-100 H-S	1,100	.....	1,860	185	.....	.....	.....	.....	.....	.....	.....	.....	.....	103,000	210′	112′	.....	.....
... Transport	CML	2	2 M-85	850	.....	.....	250	.....	.....	.....	.....	.....	.....	.....	.....	.....	14,500	68′ 2″	49′ 2″	.....	.....
... Transport	CML	2	2 M-63	1,100	.....	1,620	230	8,500	185	10,000	.....	.....	.....	.....	.....	.....	26,000	95′	64′ 6″	16′ 11″	.....
... Transport	CML	2	2 M-22	480	.....	.....	155	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
-2... Transport	CML	1	1 M-26	.....	.....	.....	127	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,980	49′ 11″	32′	.....	.....
-3... Transport	CML	.....	1 M-22	480	.....	.....	124	.....	.....	.....	.....	.....	.....	.....	.....	.....	33,000	138′	87′	.....	.....
-11... Transport	CML	.....	2	.....	.....	.....	252	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,864	49′ 2.5″	.....	.....	.....
... Bomber-Transport	CML	6–8	4 M-34	830	.....	800	124	.....	.....	.....	.....	.....	.....	.....	.....	.....	33,000	138′	87′	.....	.....
-3... Reconnaissance	CMF	2	2 M-25 Cy	630	.....	960	200	.....	.....	.....	.....	.....	16,400	.....	.....	.....	11,286	65′ 6″	47′ 5″	.....	.....
-1... Reconnaissance	CMF	2	1 M-63	1,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
-2... Reconnaissance	CMF	5	1 M-17 BMW	680	.....	620	140	.....	.....	.....	.....	.....	17,050	.....	.....	.....	.....	44′	.....	.....	.....
-5... Reconnaissance	CBF	3	1 M-17 BMW	680	.....	620	140	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,780	51′ 2″	37′ 6″	.....	.....
-6... Reconnaissance	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Reconnaissance	CMF	6–9	2 P&W	1,200	.....	4,000	190	10,500	.....	.....	.....	1,100	25,200	.....	.....	.....	27,080	104′	62′ 6″	18′ 6″	1,400
... Primary Trainer	OBL	2	1 M-11	110	.....	250	93	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,892	37′ 5″	26′ 8″	.....	.....
... Primary Trainer	OML	1	1 M-1	120	.....	.....	120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Primary Trainer	OML	1	1 M-11	110	.....	.....	120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
... Advanced Trainer	CML	1	1 M-63	1,000	.....	460	290	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,100	31′ 3″	21′ 11″	.....	.....
... Advanced Trainer	CML	2	1 M-105	1,100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	36′	30′	.....	.....

AVIATION'S Glider Specifications

Although the data given are from reliable sources and have been checked from every possible angle, Aviation can not assume responsibility for the figures given.

	Designation	No. seats	Speeds		Weights			Dimensions			Area (Sq. Ft.)						Wings		
			High speed	Stalling speed	Net	Gross	Wing loading	Span	Length	Height	Wing (inc. aileron)	Aileron	Fin	Rudder	Stabilizer	Elevator	Spar	Ribs	Covering
AMERICAN																			
...a Aircraft Corp.	TG-5	3	....	46	630	1,260	7.45	35′	.....	7′ 10″	169	15.52	8.95	6.8	13.66	11.54	W	WTrs	Fab
...s	BA-100	1	65	28	.....	450	3.5	44′ 4″	23′ 10″	.....	.....	.....	.....	.....	.....	.....	W	W	W Fab
...leb	BG-6	1	72	30	.....	425	3.63	32′ 3″	.....	4′ 3″	117	18	7	7	8.8	7	Sp	.....	Fab
	BG-8	2	90	40	.....	1,006	5.3	50′ 3″	.....	5′ 4″	190	31.14	3	9	15.75	11	W	.....	W
...l Aeronautical Co.	LRQ-1	12	....	....	.....	6,500+	.....	72′	40′	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
...Aero Glider Co.	J-14	2	....	30	360	740	3.0	45′	23′ 6″	.....	225	.....	.....	.....	.....	.....	SolW	Trs	Fab
...Aircraft Co.	B-75L	....	....	....	.....	.....	.....	50′	.....	6′	169	19	.....	6.9	15.2	10	LmdSp	Sp	Fab
...Aircraft Co.	TG-8	3	....	....	.....	.....	.....	35′ 2″	.....	.....	178.5	19.2	4.02	6.55	14.65	10.64	SolSp	Al	Fab
...Read & Co., Inc.	LNE-1	2	99	35	770	1,150	5.0	54′ 6″	26′ 3″	9′ 2″	213.86	30.2	6.9	12.03	9.02	14.2	W	W	Fab
...ster Aircraft Corp.	TG-2 (LNS-1)	2	72	....	460	860	4.01	52′	25′ 3″	6′ 10″	214	21.25	2.79	12.82	13.5	10.4	Me	AlFab	Al
	TG-3A	2	100	....	800	1,220	5.15	54′	27′ 7″	8′	237	17.37	5.42	11.35	16	13.10	Sp	SpPly	Fab
...craft	TG-6	3	....	....	.....	.....	.....	36′	.....	.....	169	.....	.....	.....	.....	.....	.....	.....	.....
...Aircraft Co.	CG-4A[1]	15	150	44	3,000+	6,000+	8.8	83′ 8″	48′ 2.5″	11′ 7.5″	851.5	85.4	20.8	29.0	59.4	54.6	SpPly	Sp	PlyFab
	CG-13[2]	30	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
BRITISH																			
...eed	Horsa	25	....	....	.....	.....	.....	88′	.....	67′	110.4	.....	.....	.....	.....	.....	W	W	WFab
...l Aircraft	Hotspur II	....	90	....	1,661	3,598	14.7	45′ 10.75″	39′ 8.75″	10′ 10″	272	.....	.....	.....	.....	.....	.....	.....	.....
GERMAN																			
...	DFS 230A1	10	.....		1,700	4,500	.....	69′ 11″		37′	.....	.....	.....	.....	.....	.....	.....	.....	.....
	GO 242	23	.....		3,200	8,500	.....	79′		52′ 6″	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Also built under license by Commonwealth, Ford, G & A Aircraft, General Aircraft, Gibson Refrigerator, Laister-Kaufman, Northwestern Aeronautical and Pratt Read & Co.
[2] Only other releasable data is fact that the craft carries more than twice the load of the CG-4. It is being manufactured by Ford and Northwestern Aeronautical Corp.

Aviation's American Engine Specifications

Although the data given are from reliable sources and have been checked from every possible angle, Aviation cannot assume responsibility for the figures given.

Manufacturer	Model	Cooling system	No. of cylinders	Cylinder arrangement	Propeller drive	Rating: Rated hp.	Rating: at r.p.m.	Rating: At altitude (ft.)	Rating: Octane fuel	Total dry without hub or starter	Lb. per hp.	Bore and stroke (in.)	Displacement (cu. in.)	Compression ratio	B. M. E. P.	Blower ratio	Dimensions: Diam. Mount. ring or distance between bearers	Dimensions: Ht. or O.D. (in.)	Dimensions: Length without starter	Guaranteed Fuel Cons. at Cruising Hp.—Lb./hp.-hr.	Max. Oil Cons. at rated speed.—Lb./hp.-hr.	Valve mechanism	Cylinder construction	Make spark plugs supplied with engine	Type ignition	Make ignition	Make of carburetor	Make of starter	Are exhaust manifolds provided	Shipping weight crated (lb.)	D. of C. License number
Air Cooled Motors Corp.	4AC-176-BA2	A	4	Hopp	D	65	2300	SL	73	182	2.8	4x3½	176	6.0	127		10⅝–12⅛	20	28⅝			Prr	Al, NI			Eclip	Mar.St.		No	275	221
	4AC-199-B2	A	4	Hopp	D	65	1950	SL	73	189	2.9	4¼x3½	199	6.0	133		10⅝–12⅛	20	28⅝			Prr	Al, NI			Eclip	Mar.St.		No	282	226
	4AC-199-B3	A	4	Hopp	D	65	1950	SL	73	208	3.2	4¼x3½	199	6.0	133		10⅝–12⅛	24 9/16	30 1/16			Prr	Al, NI			Eclip	Mar.St.		No	301	226
	4AC-199-D3	A	4	Hopp	D	85	2500	SL	73	209	2.46	4¼x3½	199	6.3	136		10⅝–12⅛	24 9/16	30 1/16			Prr	Al, NI			Eclip	Ma .St.		No	302	226
	4AC-199-E3	A	4	Hopp	D	90	2500	SL	80	208	2.3	4¼x3½	199	7.0	144		10⅝–12⅛	24 9/16	30 1/16			Prr	Al, NI			Eclip	Mar.St.		No	306	226
	4AC-199-E4	A	4	Hopp	D	90	2500	SL	80	228	2.53	4¼x3½	199	7.0	144		10⅝–12⅛	24 9/16	30 1/16			Prr	Al, NI			Eclip	Mar.St.		No	326	226
	4ACG-199-H3	A	4	Hopp	D	113	3500	SL	80	236	2.1	4¼x3½	199	7.0	129		10⅝–12⅛	24 ⅝	36¼			Prr	Al, NI			Eclip	Ma-.St.		No	306	226
	6AC-298-F3	A	6	Hopp	D	130	2550	SL	80	280	2.15	4¼x3½	298	7.0	136		10⅝–12⅛	24 9/16	40			Prr	Al, NI			Eclip	Mar.St.		No	350	225
	6ACT-298-J4	A	6	Hopp	D	155	2930	SL	100	330	2.13	4¼x3½	298	8.4	141		10⅝–12⅛	24⅝	40¼			Prr	Al, NI			Eclip	Mar.St.		No	410	225
	6ACG-298-H3	A	6	Hopp	G	165	3500	SL	80	329	2.0	4¼x3½	298	7.0	125		10⅝–12⅛	24 9/16	43 1/16			Prr	Al, NI			Eclip	Mar.St.		No	491	.....
Allied Aviation Corp.		A	4	LId	D	100	2285	SL	73	205	2.05	4x4.48	.....	6.25	142	.....	12.36	27	37.75	.42	....	Prr	S	BG	2M	Scint	Allied	Bend	No	450	208
Allison Div., Gen Motors	V-1710F10	W	12	V	2:1	1325	3000	SL	100	1345	1.02	5½x6	1710	6.65	167	7.48:1	18⅜	36¾	85⅝			Prr			2M	Scint	Strom		No	2150	.....
	V-1720R	W	12	V	2:1	1200	3000	15500	100	1352	1.13	5½x6	1710	6.65	152	.....	18⅜	36¾	85⅞			Prr			2M	Scint	Strom		No	2150	.....
	V-1710F21R	W	12	V	2:1	1325	3000	2500	100	1353	1.02	5½x6	1710	6.65	167	7.48:1	18⅜	36 27/32	85⅞			Prr			2M	Scint	Strom		No	2150	.....
	V-1710E19	W	12	V	2.23:1	1200	3000	15500	100	1435	1.20	5½x6	1710	6.65	152	.....	18⅜	37 9/16	194			Prr			2M	Scint	Strom		No	2380	.....
Continental Motors Corp.	A-65 Series 8	A	4	Hopp	D	65	2300	SL	73	170	2.62	3⅞x3⅝	171	6.3	.....	.....	.....	22 9/16	30 2 1/32			Prr	S	.....	M	.....	.....	.....	.....	348	.....
	A-65 Series 9	A	4	Hopp	D	65	2300	SL	73	176	2.71	3⅞x3⅝	171	6.3	.....	.....	.....	22 9/16	30 1/32			Prr	S	.....	M	.....	.....	.....	.....	353	.....
	A-75 Series 8	A	4	Hopp	D	75	2600	SL	73	170	2.27	3⅞x3⅝	171	6.3	.....	.....	.....	22 9/16	30 2 1/32			Prr	S	.....	M	.....	.....	.....	.....	348	.....
	A-75 Series 9	A	4	Hopp	D	75	2600	SL	73	176	2.35	3⅞x3⅝	171	6.3	.....	.....	.....	22 9/16	30 1/32			Prr	S	.....	M	.....	.....	.....	.....	353	.....
	A-80 Series 8	A	4	Hopp	D	80	2700	SL	80	170	2.13	3⅞x3⅝	171	7.5	.....	.....	.....	22 9/16	30 2 1/32			Prr	S	.....	M	.....	.....	.....	.....	348	.....
	A-80 Series 9	A	4	Hopp	D	80	2700	SL	80	176	2.2	3⅞x3⅝	171	7.5	.....	.....	.....	22 9/16	30 1/32			Prr	S	.....	M	.....	.....	.....	.....	358	.....
	W-670 Series A6	A	7	Rad	D	220	2075	SL	65	485	2.12	3⅛x3⅝	668	5.4	.....	20	42¼	34 3/16	.....			Prr	S	.....	M	.....	.....	.....	.....	850	.....
	W-670 Series M	A	7	Rad	D	240	2200	SL	80	485	1.98	3⅛x3⅝	668	7.1	.....	20	42¼	34 3/16	.....			Prr	S	.....	M	.....	.....	.....	.....	860	.....
	W-670 Series 6K	A	7	Rad	D	225	2175	SL	65	485	2.07	3⅛x3⅝	668	5.4	.....	20	42¼	34 3/16	.....			Prr	S	.....	M	.....	.....	.....	.....	850	.....
Jacobs Aircraft Engine Co.	L-4MB	A	7	Rad	D	225	2000	SL	73	510	2.2	5¼x5	757	5.4	118	.....	16.5	43.5	40 7/32	.530	.018	Prr	S	.....	M-Bat	Scint	St.	Eclip	No	.....	121
	L-4	A	7	Rad	D	225	2000	SL	73	480	2.1	5¼x5	757	5.375	118	.....	16.5	43.5	37 1/16	.530	.018	Prr	S	.....	Bat	Scint	St.	Eclip	No	.....	121
	L-4M	A	7	Rad	D	225	2000	SL	73	473	2.1	5¼x5	757	5.375	118	.....	16.5	43.5	40 7/32	.530	.018	Prr	S	.....	M	Scint	St.	Eclip	No	.....	121
	L-4MA7	A	7	Rad	D	225	2000	SL	73	476	2.1	5¼x5	757	5.375	118	.....	16.5	43.5	36⅝	.530	.018	Prr	S	.....	M	Scint	St.	Eclip	No	.....	121
	L-6MB	A	7	Rad	D	300	2000	SL	80	570	1.9	5½x5½	914	6	124	.....	16.5	45⅝	40 1/16	.535	.025	Prr	S	.....	M-Bat	Scint	St.	Eclip	No	.....	195
	L-6MBA	A	7	Rad	D	300	2000	SL	80	570	1.9	5½x5½	914	6	124	.....	16.5	45⅝	40 1/16	.535	.025	Prr	S	.....	M-Bat	Scint	St.	Eclip	No	.....	195
	L-6	A	7	Rad	D	300	2000	SL	80	535	1.8	5½x5½	914	6	124	.....	16.5	45⅜	38 1/16	.535	.025	Prr	S	.....	Bat	Scint	St.	Eclip	No	.....	195
	L-6M	A	7	Rad	D	300	2000	SL	80	550	1.8	5½x5½	914	6	124	.....	16.5	45⅜	40 1/16	.535	.025	Prr	S	.....	M	Scint	St.	Eclip	No	.....	195
	L-6MA	A	7	Rad	D	300	2000	SL	80	550	1 8	5½x5½	914	6	124	.....	16.5	45⅜	33 1/16	.535	.025	Prr	S	.....	M	Scint	St.	Eclip	No	.....	195
Kinner Motors, Inc.	K-5	A	5	Rad	D	100	1810	SL	73	304	3.04	4¼x5¼	372.0	5.1	118	.....	14	45⅜	31 17/32	.54	.040	Prr	A1,S	BG	M	BS	St.Hol.	Eclip	Op	600	3
	B-5&B-54	A	5	Rad	D	125	1925	SL	73	312	2.50	4⅜x5¼	441.0	5.25	117	.....	14	45⅜	31½	.54	.032	Prr	A1,S	BG	M	BS	St.Hol.	Eclip	Op	600	51
	R-5	A	5	Rad	D	160	1850	SL	73	335	2.10	5x5½	540.0	5.50	127	.....	14	45⅜	31 17/32	.54	.025	Prr	A1,S	BG	M	BS	St.Hol.	Eclip	No	600	153
	R-55	A	5	Rad	D	160	1850	SL	73	345	2.15	5x5½	540.0	5.50	127	.....	14	45⅜	33⅝	.54	.025	Prr	A1,S	BG	M	BS	St.Hol.	Eclip	No	600	153
	R-53	A	5	Rad	D	175	2100	SL	73	351	2.0	5x5½	540.0	6.0	122	.....	14	45⅜	33⅝	.54	.023	Prr	A1,S	BG	M	BS	St.Hol.	Eclip	No	600	153
	C-7	A	7	Rad	D	300	1800	SL	73	600	2.0	5⅝x6	1044	5.25	126	1:1	20	47¾	42 15/16	.54	.025	Prr	A1,S	BG	M	BS	St.Hol.	Eclip	Op	1200	122
	SC-7	A	7	Rad	D	350	1900	SL	73	650	1.85	5⅝x6	1044	5.50	140	9.71:1	20	47¾	44¼	.54	.021	Prr	A1,S	BG	M	BS	St.Hol.	Eclip	Op	1300	175
	R-56	A	5	Rad	D	160	1850	SL	73	362	2.26	5x5½	540.0	5.50	127	.....	14	45⅜	33⅜	.54	.025	Prr	A1,S	BG	M	BS	St.Hol.	Eclip	No	600	153
Lycoming Div., Aviation Corp	O-145-BZ	A	4	Hopp	D	65	2550	SL	73	163.4	....	3.625x3.5	144.49	6.5	.....	.....	8.5–10.25	20.59	24.62	.....	.....	Prr	.....	.....	2M	.....	Scint Sup	Mar. or Splitdorf Strom	No	206.4	210
	GO-145-C2	A	4	Hopp	Z7:17	75	3200	SL	73	196.39	....	3.625x3.5	144.49	6.5	.....	.....	8.5–10.25	20.59	29.31	.....	.....	Prr	.....	.....	2M	.....	Scint Sup	Mar. or Splitdorf Strom	No	247.27	210
	O-235	A	4	Hopp	D	100	2550	SL	73	234.60	....	4.37x3.875	233.30	6.25	.....	.....	11.50	25.02	33.25	.....	.....	Prr	.....	.....	2M	.....	Scint	Marvel	No	287.63	223
	O-290	A	4	Hopp	D	125	2450	SL	73	243.60	....	4.875x3.875	289	6.25	.....	.....	11.50	25.49	29.93	.....	.....	Prr	.....	.....	2M	.....	Scint	Marvel	No	296.63	229
	O-350	A	6	Hopp	D	150	2500	SL	73	340.99	....	4.875x3.875	349.50	6.25	.....	.....	14.00	26.26	39.94	.....	.....	Prr	.....	.....	2M	.....	Scint	Marvel	No	394.7	227
	O-435	A	6	Hopp	D	175	2300	SL	73	346.48	....	4.875x3.875	434	6.25	.....	.....	14.00	26.36	39.94	.....	.....	Prr	.....	.....	2M	.....	Scint	Marvel	No	402.99	228
	R-680-E3A	A	9	Rad	D	300	2300	SL	87	515.0	....	4.625x4.50	680	7.00	....	1:1	19.25	43.5	37.50	.....	.....	Prr	.....	.....	2M	.....	Scint	Marvel	No	1041.3	202

A —Air cooled
Al —Aluminum alloy
B —Battery
D —Direct
G —Geared
Hopp—Horizontal opposed
LId —Inline inverted
M —Magneto
NI —Nickel iron
Prr —Push rod-rocker
Rad —Radial
S —Steel
SL —Sea level
W —Liquid cooled

Aviation's American Engine Specifications—(Cont.)

Aviation's American Engine Specifications—(Cont.)

Manufacturer	Model	Cooling system	Number of cylinders	Cylinder arrangement	Propeller drive	Rating: Rated hp.	Rating: at r.p.m.	Rating: At altitude (ft.)	Rating: Octane fuel	Total dry without hub starter	Lb. per hp.	Bore and stroke (in.)	Displacement (cu. in.)	Compression ratio	B. M. E. P.	Blower ratio	Dimensions: Diam. Mount. ring or distance between bearers	Dimensions: Ht. or O.D. (in.)	Dimensions: Length without starter	Guaranteed Fuel Cons. at Cruising Hp.—Lb./hp.-hr.	Max. Oil Cons. at rated speed.—Lb./hp.-hr.	Valve mechanism	Cylinder construction	Make spark plugs supplied with engine	Type ignition	Make ignition	Make of carburetor	Make of starter	Are exhaust manifolds provided	Shipping weight crated (lb.)	D. of C. License number
Packard Motor Car Co.	Rolls Royce V-1650-1	W	12	V	G	1080	2650	9500	100	1480	1.37	5.4x6	1649	6.0	196	8.15:1	.....	41¼	79¾	.....	.....	OHC	S	.....	2M	C-5	Bendix	Strom	No	2500	.....
Pratt & Whitney, Division of United Aircraft Corp.[1]	R-985-SB3	A	9	Rad	D	400	2200	5000	91	668	1.67	5¼6x5¼6	985	6.0	118	10:1	.....	46.13	42⁷⁄₁₆	.....	.....	Prr	A1,S	.....	2M	Scint	Strom	.....	No	.....	.....
	R-1340-S3H1	A	9	Rad	D	550	2200	5000	91	864	1.57	5¾x5¾	1344	6.0	118	10:1	.....	51.75	43	.....	.....	Prr	A1,S	.....	2M	Scint	Strom	.....	No	.....	.....
	R-1340-S1H1	A	9	Rad	D	550	2200	8000	91	864	1.57	5¾x5¾	1344	6.0	118	12:1	.....	51.75	43	.....	.....	Prr	A1,S	.....	2M	Scint	Strom	.....	No	.....	.....
	R-1830-S1C3-G	A	14	Rad	3:2	1050	2550	7500	91	1438	1.37	5½x5½	1830	6.7	130	17.5:1	.....	48.13	61⁵⁄₃₂	.....	.....	Prr	A1,S	.....	2M	Scint	Strom	.....	.....	.....	.....
	R-2800	A	18	Rad	.....	2000	.....	.....	.....	.....	.....	5¾x6	2804	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Scint	.....	.....	.....	.....	.....
Ranger Aircraft Engines, Div., Fairchild Eng. & Aircraft Corp.	6-440C-5	A	6	Lid	D	200	2450	SL	87	395	1.98	4⅛x5½	441	7.5	146	.....	17⅞	33½	53⁵⁄₃₂	.55	.025	Uho	S	BG	M	Scint	Mar.	.....	No	.....	ATC 216
	SGV-770C-1B	A	12	Vid	3:2	450	3000	12000	91	780	1.73	4x5⅛	773	6.5	154	9.5:1	13⅜	34⅛	66²⁹⁄₆₄	.53	.025	Uho	S	BG	M	Scint	St.	.....	No	.....	.....
Warner Aircraft Corp.	Scarab	A	7	Rad	D	125	2050	SL	73	285	2.28	4¼x4¼	422	5.2	115	.....	17	36⁹⁄₁₆	29	.....	.025	Prr	S	Chmp	M	Scint	St.	.....	No	510	2
	Super Scarab	A	7	Rad	D	145	2050	SL	73	305	2.1	4⅝x4¼	499	5.3	115	.....	17	36⁹⁄₁₆	29¾	.....	.025	Prr	S	Chmp	M	Scint	Hol.	.....	No	585	104
	Super Scarab	A	7	Rad	D	165	2100	SL	73	332	2.01	4⅝x4¼	499	6.4	123	.....	17½	37¼	30²⁵⁄₆₄	.....	.025	Prr	S	Chmp	M	Scint	St.	.....	No	595	214
	R 550-1	A	7	Rad	D	180	2100	SL	73	371	2.06	4⅞x4¼	550	6.2	123	.....	17½	37¼	29⁹⁄₁₆	.....	.025	Prr	S	Chmp	M	Scint	Hol.	.....	No	614	.....
Wright Aeronautical Corp.[2]	R-760-ET	A	7	Rad	D	235	2000	SL	73	540	2.3	5x5½	756	6.1	110	.....	19¼	45	42.44	.480	.025	Prr	A1,S	Op	M	Scint	St.	Op	Yes	1080	126
	R-760-E1	A	7	Rad	D	300	2250	SL	73	570	1.9	5x5½	756	6.1	117	7.05	19¼	45	42.44	.470	.025	Prr	A1,S	Op	M	Scint	St.	Op	Yes	1050	94
	R-760-E2	A	7	Rad	D	350	2400	SL	91	570	1.63	5x5½	756	6.3	117	9.17	19¼	45	42.44	.485	.025	Prr	A1,S	Op	M	Scint	St.	Op	Yes	1080	155
	R-975-E1	A	9	Rad	D	365	2100	SL	73	660	1.81	5x5½	973	6.1	118	7.8	19¼	45	41.2	.470	.025	Prr	A1,S	Op	M	Scint	St.	Op	Yes	1190	87
	R-975-E3	A	9	Rad	D	450	2250	SL	91	675	1.5	5x5½	973	6.3	132	10.15	19¼	45	41.2	.46	.025	Prr	A1,S	Op	M	Scint	St.	Op	Yes	1215	125
	P-1820-F52	A	9	Rad	D	890	2200	SL	91	1000	1.12	6¼x6⅞	1823	6.4	126	7.0	23⅜	54.12	43.38	.44	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1750	148
	GR-1820-F52	A	9	Rad	G3	875	2200	SL	91	1095	1.25	6¼x6⅞	1823	6.4	126	7.0	23⅜	54.12	47.81	.45	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	148
	R-1820-F53	A	9	Rad	D	785	2200	SL	91	1000	1.27	6¼x6⅞	1823	6.4	126	8.1	23⅜	54.12	43.38	.47	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1750	149
	GR-1820-F53	A	9	Rad	G3	770	2200	SL	91	1095	1.42	6¼x6⅞	1823	6.4	126	8.1	23⅜	54.12	47.81	.48	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	149
	R-1820-F55	A	9	Rad	D	875	2200	SL	91	1012	1.15	6¼x6⅞	1823	6.4	126	7.14&10	23⅜	54.12	43.38	.45	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1750	198
	GR-1820-F55	A	9	Rad	G3	875	2200	SL	91	1107	1.26	6¼x6⅞	1823	6.4	126	7.14&10	23⅜	54.12	47.81	.45	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	198
	R-1820-F56	A	9	Rad	D	785	2200	SL	91	1000	1.27	6¼x6⅞	1823	6.4	126	8.83	23⅜	54.12	43.38	.485	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1750	159
	GR-1820-F56	A	9	Rad	G3	770	2200	SL	91	1045	1.42	6¼x6⅞	1823	6.4	126	8.83	23⅜	54.12	47.81	.495	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	159
	R-1820-F62	A	9	Rad	D	900	2350	SL	91	1000	1.10	6¼x6⅞	1823	6.4	126	7.0	23⅜	54.12	43.38	.450	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1750	148
	GR-1820-F62	A	9	Rad	G3	900	2350	SL	91	1095	1.21	6¼x6⅞	1823	6.4	126	7.0	23⅜	54.12	47.81	.450	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	148
	R-1820-F65	A	9	Rad	D	900	2350	SL	91	1012	1.12	6¼x6⅞	1823	6.4	126	7.14&10	23⅜	54.12	47.81	.450	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1750	198
	GR-1820-F65	A	9	Rad	G3	900	2350	SL	91	1107	1.23	6¼x6⅞	1823	6.4	126	7.14&10	23⅜	54.12	47.81	.450	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	198
	R-1870-G2	A	9	Rad	D	1000	2200	SL	91	1103	1.1	6¼x6⅞	1823	6.45	137	7.0	23⅜	54¼	43¼	.44	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	157
	GR-1820-G2	A	9	Rad	G3	1000	2200	SL	91	1198	1.2	6¼x6⅞	1823	6.45	137	7.0	23⅜	54¼	47¾	.44	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1950	157
	R-1820-G3	A	9	Rad	D	875	2200	SL	91	1103	1.26	6¼x6⅞	1823	6.45	137	8.31	23⅜	54¼	43¼	.475	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	171
	GR-1820-G3	A	9	Rad	G3	875	2200	SL	91	1198	1.37	6¼x6⅞	1823	6.45	137	8.31	23⅜	54¼	47¾	.475	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1950	171
	R-1820-G3B	A	9	Rad	D	900	2350	SL	91	1103	1.23	6¼x6⅞	1823	6.2	137	8.31	23⅜	54¼	43¼	.480	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	171
	GR-1820-G3B	A	9	Rad	G3	900	2350	SL	91	1198	1.33	6¼x6⅞	1823	6.2	137	8.31	23⅜	54¼	47¾	.480	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1950	171
	R-1820-G5	A	9	Rad	D	1000	2200	SL	91	1115	1.11	6¼x6⅞	1823	6.45	137	7.14&10	23⅜	54¼	43¼	.440	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	154
	GR-1820-G5	A	9	Rad	G3	1000	2200	SL	91	1210	1.21	6¼x6⅞	1823	6.45	137	7.14&10	23⅜	54¼	47¾	.440	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1950	154
	R-1820-G5E	A	9	Rad	D	1000	2200	SL	91	1139	1.14	6¼x6⅞	1823	6.45	137	7.14&10	23⅜	54¼	43¼	.440	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1850	154
	GR-1820-G5E	A	9	Rad	G3	1000	2200	SL	91	1234	1.23	6¼x6⅞	1823	6.45	137	7.14&10	23⅜	54¼	47¾	.440	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	1950	154
	GR-1820-G102A	A	9	Rad	G1,G3	1100	2350	SL	91	1275	1.16	6¼x6⅞	1823	6.3	143	7.0	23⅜	55.1	48.12	.460	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2040	169
	GR-1820-G103A	A	9	Rad	G1,G3	1000	2350	SL	91	1275	1.27	6¼x6⅞	1823	6.3	143	8.31	23⅜	55.1	48.12	.480	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2040	180
	GR-1820-G105A	A	9	Rad	G1,G3	1100	2350	SL	91	1287	1.17	6¼x6⅞	1823	6.3	143	7.14&10	23⅜	55.1	48.12	.460	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2055	192
	718-C9-GB1	A	9	Rad	G1,G3	1100	2350	SL	91	1287	1.17	6¼x6⅞	1823	6.3	143	7.14&10	23⅜	55.1	48.12	.465	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2057	192
	702-C9-GC	A	9	Rad	G1,G7	1200	2500	SL	91	1310	1.09	6¼x6⅞	1823	6.7	152	7.0	23⅜	55⅛	40.04	.465	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2057	219
	GR-1820-G203A	A	9	Rad	G1,G7	1100	2500	SL	91	1310	1.19	6¼x6⅞	1823	6.7	141	8.3	23⅜	55⅛	50.04	.490	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2090	.....
	704-C9-GC	A	9	Rad	G1,G7	1200	2500	SL	91 & 100	1320	1.10	6¼x6⅞	1823	6.7	152	7.14&10	23⅜	55⅛	50.04	.465	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2057	219
	728-C9-GC	A	9	Rad	G1,G7	1200	2500	SL	91	1310	1.09	6¼x6⅞	1823	6.3	152	7.0	23⅜	55⅛	50.04	.465	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2055	219
	730-C9-GC	A	9	Rad	G1,G7	1200	2500	SL	91	1310	1.09	6¼x6⅞	1823	6.2	152	7.0	23⅜	55⅛	50.04	.480	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2090	219
	579-C14-AC1	A	14	Rad	G7	1600	2400	SL	100	1935	1.21	6¼x6⁹⁄₁₆	2603	6.85	144	7.0	25	55	62.06	.450	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2910	179
	GR-2600-A2B	A	14	Rad	G7	1600	2400	SL	91	1935	1.21	6¼x6⁹⁄₁₆	2603	6.3	144	7.0	25	55	62.06	.440	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2910	176
	GR-2600-A5A	A	14	Rad	G7	1600	2400	SL	100	1950	1.22	6¼x6⁹⁄₁₆	2603	6.85	144	7.14&10	25	55	62.06	.440	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2925	.....
	GR-2600-A5B	A	14	Rad	G7	1600	2400	SL	91	1950	1.22	6¼x6⁹⁄₁₆	2603	6 3	144	7.14&10	25	55	62.06	.440	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2925	.....
	585-C14-BA	A	14	Rad	G7	1700	2500	SL	100	1965	1.15	6¼x6⁹⁄₁₆	2603	6.9	152	7.3	25	54¼	63.40	.460	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2925	176
	586-C14-BA	A	14	Rad	G7,G8	1700	2500	SL	100	1980	1.16	6¼x6⁹⁄₁₆	2603	6.85	152	7.06& 10.02	25	54¼	63.40	.460	.025	Prr	A1,S	Op	M	Scint	St.Hol.	Op	No	2955	176
		A	18	Rad	G	2200	.....	.....	.....	.....	.....	.....	3350	.....	.....	.....	.....	55	.....	.....	.....	Prr	.....	.....	.....	.....	.....	.....	.....	.....	.....

A —Air cooled B —Battery G —Geared LId —Inline inverted NI —Nickel iron Rad —Radial SL —Sea level St —Stromberg
Al —Aluminum alloy D —Direct Hopp —Horizontal opposed M —Magneto Prr —Push rod-rocker S —Steel W —Liquid cooled Hol —Holly

[1] *Some models manufactured under license by Buick, Chevrolet, Continental, Ford, Jacobs and Nash-Kelvinator.* [2] *Some models manufactured under license by Chrysler and Studebaker.*

Foreign Aircraft Engine Specifications

BRITISH

Manufacturer	Model	Cooling system	Number of cylinders	Cylinder arrangement	Propeller drive	Rating: Rated hp.	Rating: At r.p.m.	Rating: At altitude (ft.)	Rating: Octane fuel	Weights: Total dry without hub or starter	Weights: Lb. per hp.	Bore and stroke (in.)	Displacement (cu. in.)	Compression ratio	B.M.E.P.	Blower ratio	Dimensions: Ht. or O.D. (in.)	Dimensions: Length without starter	Guaranteed fuel consumption at 9 max. cruising hp. (lb. per hp. per hr.)	Max. oil consumption at rated speed	Valve mechanism	Cylinder construction	Type ignition	Make ignition	Make of carburetors	Make of starter
Alvis, Ltd.	Pelides	A	14	S.Rad	G	1060	2150	S.L.	87	1475	1.43	5.75x6.5	2360	6.1	160	7.125:1	52	67	.....	.....	prr	N.S.	2M	.....	Z	.....
Alvis, Ltd.	Pelides Major	A	14	S.Rad	G	1010	2300	S.L.	87	1475	.....	5.75x6.5	2360	6.1	145	8.826:1	52	67	.....	.....	prr	N.S.	2M	.....	Z	.....
Alvis, Ltd.	Leonides	A	9	Rad	G	450	3000	S.L.	87	708	1.70	4.80x4.41	718.5	6.3:1	152	6.5:1	41.5	52	.....	.....	prr	N.S.	2M	.....	Z	.....
Armstrong Siddeley Motors, Ltd.	Cheetah XI	A	7	Rad	G	415	2650	7500	87	750	1.80	5.00x5.25	759	6.35:1	163	6.25:1	43.3	52.7	.....	.....	prr	Hi.	2M	.....	C.H.	.....
Armstrong Siddeley Motors, Ltd.	Panther X	A	14	Rad	G	700	2250	3000	87	1070	1.53	5.25x5.5	1667	6.35:1	147	5.88:1	47.7	59	.....	.....	prr	AL.	2M	.....	C.H.	.....
Armstrong Siddeley Motors, Ltd.	Tiger IXC	A	14	Rad	G	805	2375	6500	87	1260	1.62	5.5 x6	1996.4	6.25:1	129	4.5:1	50.8	68.3	.....	.....	prr	S.-AL.	2M	.....	C.H.	.....
Bristol Aeroplane Co., Ltd.	Mercury XII	A	9	Rad	G	820	2400	3500	87	1010	1.22	5.75x6.5	1520	6.25:1	178	.....	51.5	.....	.....	.....	prr	AL.	2M	Rotax	C.H.	.....
Bristol Aeroplane Co., Ltd.	Pegasus XXVII	A	9	Rad	G	830	2475	11000	87	1040	1.25	5.75x7.50	1753	6.572:1	151	.....	55.3	.....	.....	.....	prr	S.	2M	Rotax	C.H.	.....
Bristol Aeroplane Co., Ltd.	Hercules II	A	14	S.Rad	G	1150	2400	5000	..	1680	1.46	5.75x6.5	2360	.....	160	.....	52	.....	.....	.....	.....	.....	2M	Rotax	C.H.	.....
Bristol Aeroplane Co., Ltd.	Taurus II	A	14	S.Rad	G	900	2800	5000	..	1300	1.44	5.00x5.6	1550	.....	164	.....	46.25	.....	.....	.....	.....	.....	2M	Rotax	C.H.	.....
Bristol Aeroplane Co., Ltd.	Perseus XIVC	A	9	Rad	G	710	2400	4000	..	1100	1.57	5.75x6.5	1520	.....	154	.....	52	.....	.....	.....	.....	.....	2M	Rotax	C.H.	.....
Bristol Aeroplane Co., Ltd.	Aquila IV	A	9	Rad	G	470	2600	4500	73	830	1.76	5.00x5.37	950	.....	150	.....	46	.....	.....	.....	.....	.....	2M	Rotax	C.H.	.....
Blackburn Aircraft Ltd.	Cirrus Major	A	4	L.Id	D	150	2450	S.L.	..	325	2.35	4.72x5.51	386	5.8:1	128	.....	29.96	42.91	.....	1-2	prr	S.	2M	.....	C.H.	.....
De Havilland Aircraft Co., Ltd.	Gipsy Major II	A	4	L.Id	D	140	2400	S.L.	77	315	2.52	4.65x5.51	374	6:1	126	.....	32	50.35	.....	.....	prr	S.	2M	.....	Z	.....
De Havilland Aircraft Co., Ltd.	Gipsy Six	A	6	L.Id	D	205	2400	S.L.	77	469	.....	4.65x5.51	561	6:1	126	.....	31.7	63.5	.....	.....	prr	S.	2M	.....	Z	.....
De Havilland Aircraft Co., Ltd.	Gipsy Twelve	A	12	IdV	G	425	2450	7500	..	1058	2.52	4.65x5.51	1121	6:1	123	.....	37.4	82.6	.478	.....	prr	CB.-S.	2M	.....	C.H.	.....
D. Napier & Son, Ltd.	Rapier	A	16	(H)	G	395	4000	6000	..	707	1.98	3.5 x3.5	538.78	7:1	140	5.27:1	36	56.62	.427	.0315	prr	S.	2M	.....	C.H.	.....
D. Napier & Son, Ltd.	Napier-Halford Dagger	A	24	(H)	G	955	4200	S.L.	87	1390	1.56	3.8 x3.75	1027	7.5:1	171	.....	47.81	73.87	.....	.....	prr	S.	2M	.....	C.H.	Rotax
D. Napier & Son, Ltd.	Napier Sabre	W	24	(H)	G	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pobjoy Airmotors & Aircraft, Ltd.	Niagara	A	7	Rad	G	142	4600	S.L.	87	175	1.4	3.19x3.43	192	8.1	128	.....	26.5	.....	.....	.....	prr	S.-Al.	2M	Rotax	C.H.	.....
Rolls-Royce, Ltd.	Merlin IV	W	12	V	G	990	2600	12250	87	1335	1.35	5.4 x6	1647	.....	183	.....	41.17	75.0	.....	.....	prr	AL.CB.S.	2M	.....	R.-R.	.....
Rolls-Royce, Ltd.	Peregrine	W	12	V	G	860	2850	13500	87	1106	1.28	5.00x5.5	1297	.....	184	.....	.....	.....	.....	.....	prr	AL.CB.S.	2M	.....	R.-R.	.....
Rolls-Royce, Ltd.	Kestrel XVI	W	12	V	G	690	2500	3000	87	955	1.59	5.00x5.50	1297	6:1	162	.....	40.27	69.8	.....	.....	prr	.....	2M	.....	R.-R.	.....
Rolls-Royce, Ltd.	Merlin XX	W	12	V	G	1240	2850	10000	..	1450	1.17	5.4 x6	1650	6.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rolls-Royce, Ltd.	Merlin LXI	W	12	V	G	.....	.....	.....	.....	1640	.....	5.4 x6	1647	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rolls-Royce, Ltd.	Vulture	W	24	X	G	1845	3000	5000	..	.....	.....	5.00x5.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

GERMAN

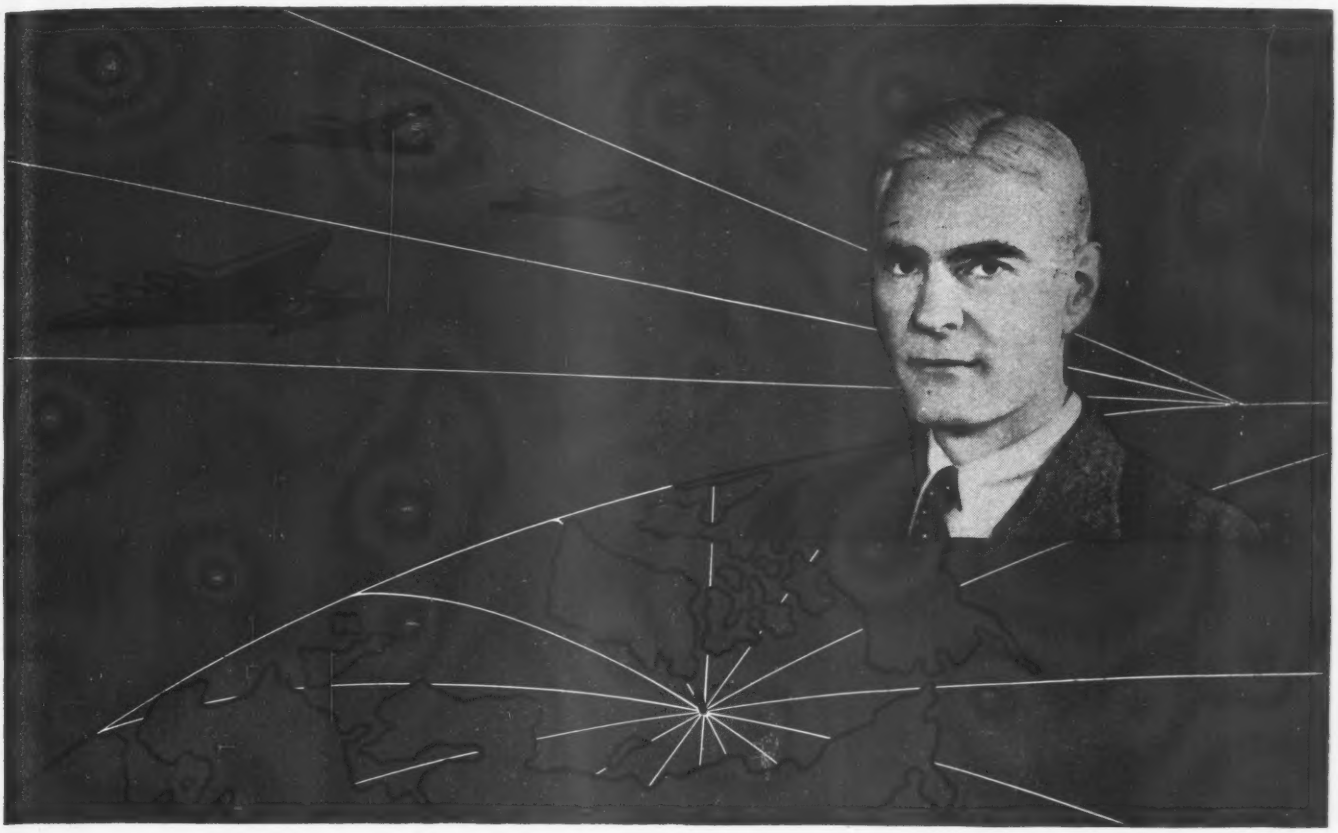
Manufacturer	Model	Cooling system	Number of cylinders	Cylinder arrangement	Propeller drive	Rating: Rated hp.	Rating: At r.p.m.	Rating: At altitude (ft.)	Rating: Octane fuel	Weights: Total dry without hub or starter	Weights: Lb. per hp.	Bore and stroke (in.)	Displacement (cu. in.)	Compression ratio	B.M.E.P.	Blower ratio	Dimensions: Ht. or O.D. (in.)	Dimensions: Length without starter	Guaranteed fuel consumption at 9 max. cruising hp. (lb. per hp. per hr.)	Max. oil consumption at rated speed	Valve mechanism	Cylinder construction	Type ignition	Make ignition	Make of carburetors	Make of starter
Argus Motoren G.m.b.H.	Argus As. 410	A	12	V.Id	G	465	3100	S.L.	..	694.5	2.06	4.1 x4.5	732.3	6.4:1	123	.....	38.18	62.4	.44	.....	prr	S.-AL.	M	.....	.....	.....
Bayerische Motoren Werke A.G.	B.M.W. 132	A	9	Rad	D	830	2150	3280	..	1015	1.24	6.12x6.37	1690	6.5:1	180	.....	54.33	49.29	.507	.....	prr	S.-AL.	M	Bosch	Pallas	Bosch
Bayerische Motoren Werke A.G.	B.M.W. 801A	A	14	Rad	G	1460	2400	16250	..	2430	.....	6.15x6.15	2520	6.5:1	.....	5.07x1	52.	58.	.....	.....	prr	S.	2M	Bosch	.....	Bosch
Bayerische Motoren Werke A.G.	B.M.W. 802	A	14	Rad	G	2000*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Brandenburgische Motorenwerke.	Bramo Fafnir 323	A	9	Rad	G	920	2500	S.L.	..	1199	1.44	6.00x6.3	1636	6.4:1	173	.....	54.6	55.8	.....	.....	prr	.....	M	.....	.....	.....
Diamler-Benz Aktiengesellschaft.	Mercedes-Benz D-B 600	W	12	V.Id	G	800	2200	S.L.	87	1200	1.5	5.91x6.3	2069	6.5:1	139	.....	39.37	67.7	.495	.0111	ohc	S.	M	Bosch	.....	.....
Diamler-Benz Aktiengesellschaft.	Mercedes-Benz D-B 602 Die	W	16	V	G	1200	1600	S.L.	..	4400	4.88	6.89x9.05	5401	16:1	48	.....	53.19	106	.37	.0066	prr	S.	.....	.....	.....	.....
Diamler-Benz Aktiengesellschaft.	Mercedes-Benz D-B 601	W	12	V.Id	G	1050	2500	S.L.	..	1268	1.27	5.91x6.3	2069	6.9:1	153	.....	40.5	67.5	.....	.....	ohc	.....	.....	Bosch	.....	.....
Hirth Motoren G.m.b.H.	H.M. 506-A	A	6	L.Id	D	160	2500	S.L.	..	328	2.31	4.1 x4.52	364.7	6:1	119	.....	28.66	49.8	.495	.....	prr	C.	M	Bosch	Pallas Zenith	.....
Hirth Motoren G.m.b.H.	H.M. 508D-1	A	8	V.Id	G	280	3000	S.L.	..	485	2.	4.1 x4.52	486.4	6:1	127	.....	32.05	51.5	.571	.....	prr	C.	M	Bosch	Pallas Zenith	.....
Hirth Motoren G.m.b.H.	H.M. 512-A	A	12	V.Id	G	400	3100	S.L.	..	593	1.98	4.1 x4.52	728	6:1	116	4.4:1	32	61	.473	.005	prr	C.	M	Bosch	Pallas Zenith	.....
Junkers Motorenwerke A.G.	Die. Jumo 205-C	W	6	Vl-Opp	G1	510	2100	S.L.	..	1147	2.25	4.13x2.x6.3	1014	17:1	94	.....	52.16	76.5	.385	.002	.....	S.	.....	.....	.....	.....
Junkers Motorenwerke A.G.	Jumo 210-B	W	12	V.Id	G	540	2600	S.L.	87	958	1.70	4.88x5.3	1202	6.5:1	136	.....	70.87	58.19	.....	.....	prr	S.-AL.	M	.....	.....	.....
Junkers Motorenwerke A.G.	Jumo 210-G	W	12	V.Id	G	700	2700	S.L.	..	983	1.40	4.88x5.3	.....	6.5:1	170	.....	37.91	58.19	.504	.....	prr	S.-AL.	M	.....	.....	.....
Junkers Motorenwerke A.G.	Jumo 211-C	W	12	V.Id	G	1000	2300	S.L.	..	1278	1.59	5.91x6.5	2136	6.5:1	.....	.....	40.67	66.46	.....	.....	prr	S.-AL.	M	.....	.....	.....
Junkers Motorenwerke A.G.	Jumo 211-Ba	W	12	V.Id	G	1100	2400	S.L.	..	1356	1.24	5.91x6.5	.....	6.5:1	.....	.....	41.69	68.7	.470	.....	.....	S.-AL.	M	.....	.....	.....

ITALIAN

Manufacturer	Model	Cooling system	Number of cylinders	Cylinder arrangement	Propeller drive	Rating: Rated hp.	Rating: At r.p.m.	Rating: At altitude (ft.)	Rating: Octane fuel	Weights: Total dry without hub or starter	Weights: Lb. per hp.	Bore and stroke (in.)	Displacement (cu. in.)	Compression ratio	B.M.E.P.	Blower ratio	Dimensions: Ht. or O.D. (in.)	Dimensions: Length without starter	Guaranteed fuel consumption at 9 max. cruising hp. (lb. per hp. per hr.)	Max. oil consumption at rated speed	Valve mechanism	Cylinder construction	Type ignition	Make ignition	Make of carburetors	Make of starter
Alfa-Romeo	126 R.C. 34	A	9	Rad	G	750	2300	11150	87	1068	1.42	5.75x7.48	1747	6.5:1	153	10:1	55.4	52.3	.45	.....	prr	N.-S.	2M	Marelli	Mona Hobson	.....
Alfa-Romeo	126 R.C. 10	A	9	Rad	G	800	2300	3280	87	1068	1.42	5.75x7.48	1747	6.5:1	157	7:1	55.4	52.3	.....	.....	prr	N.-S.	2M	Marelli	Mona Hobson	.....
Afa-Romeo	127 R.C. 55	A	9	Rad	G	650	2400	18000	87	1054	1.62	5.75x7.48	1747	7.12:1	122	7.12:1	55.4	52.3	.....	.....	prr	N.-S.	2M	Marelli	Mona Hobson	.....
Alfa-Romeo	128 R.C. 21	A	9	Rad	G	860	2300	6900	87	1135	1.32	5.75x7.48	1747	8.8:1	144	7:1	55.4	52.3	.....	.....	prr	N.-S.	2M	Marelli	Mona Hobson	.....
Alfa-Romeo	130 R.C. 32	A	9	Rad	G	700	2400	10500	87	1012	1.44	5.75x6.5	1516	6.5:1	152	8.8:1	.....	.....	.....	.....	prr	N.-S.	2M	.....	.....	.....
Alfa-Romeo	135 R.C. 34	A	18	S.Rad	G	1400	2400	10500	87	2100	1.5	5.75x6.3	2940	6.6:1	157	9.26:1	51.8	70	.....	.....	prr	N.-S.	2M	.....	Zenith	.....
Alfa-Romeo	110-1	A	4	L.Id	D	120	2100	S.L.	87	322	2.68	4.65x5.51	373.5	5.55:1	121	.....	.....	.....	.53	.....	prr	S.	2M	.....	Mona Hobson	Ec.
Alfa-Romeo	115-1	A	6	L.Id	D	185	2100	S.L.	..	476	2.57	4.65x5.51	560	5.55:1	125	.....	.....	.....	.52	.....	.....	.....	.....	.....	Mona Hobson	Ec.
Compagnia Naziorale Aeronautica.	C.N.A. C.V.I. I.R.C. 43	A	6	L.Id	G	160	3600	S.L.	..	408	2.7	3.54x4.33	256	.....	136.5	.....	.....	.....	.54	.....	.....	S.-AL.	.....	.....	.....	.....
Compagnia Nazionale Aeronautica.	C.N.A. C. 7	A	9	Rad	G	180	4800	S.L.	..	275	1.53	3.14x3.33	235	7.1:1	126	1.	.....	.....	.....	.....	.....	S.-AL.	2M	Marelli	Memini	.....
Societa Anonima F.I.A.T.	A-74-R.C. 38	A	14	S.Rad	G	840	2400	12450	87	1257	1.49	5.51x5.70	1907	7:1	145	8.7:1	47.07	59.45	.595	.....	.....	S.-AL.	2M	Marelli	.....	.....
Societa Anonima F.I.A.T.	A-74-R.C.I. 42	A	14	S.Rad	G	770	2300	13760	87	1257	1.49	5.51x5.70	1907	7:1	145	8.7:1	47.07	59.45	.595	.....	.....	S.-AL.	2M	Marelli	.....	.....
Societa Anonima F.I.A.T.	A-80-R.C. 41	A	18	S.Rad	G	1000	2100	13445	87	1600	1.6	5.51x6.50	2788	6.7:1	135	9.37:1	52.56	59.37	.595	.....	.....	AL.-S	2M	Marelli	.....	.....
Societa Anonima F.I.A.T.	A-82-R.C. 42	A	18	S.Rad	G	1250	2300	13800	..	1916	1.53	5.51x6.50	2788	6.7:1	135	9.37:1	52.56	59.37	.....	.....	.....	AL.-S.	2M	Marelli	.....	.....
Isotta-Fraschini.	Asso L-121-R.C. 40	W	12	V	G	900	2350	13120	..	1310	1.45	5.75x6.3	1992	6.4:1	154	10.7:1	43.54	83.78	.529	.....	.....	S.	2M	.....	I.F.	.....
Isotta-Fraschini.	Asso L-1801-R.C. 15/40	W	18	Id-W	G	1350	2350	13120	87	.....	.....	5.75x6.3	2945	6.4:1	154	.....	49.06	100	.525	.....	.....	S.	.....	.....	.....	.....
Isotta-Fraschini.	Delta R.C. 35 I.S.	W	12	V.Id	G	700	2400	11480	87	1122	1.60	5.2 x6.3	1605	6.4:1	134	5.95:1	34.79	78.8	.594	.022	.....	S.-AL.	2M	.....	I.F.	.....
Isotta-Fraschini.	Gamma R.C. 151	W	12	V.Id	G	515	2500	11480	87	858	1.66	4.9x5.11	1171	6.5:1	139	.....	.....	.....	.572	.013	.....	S.-AL.	2M	.....	I.F.	.....
Piaggio & C. Societa Anonima	P.X.R.	A	9	Rad	G	670	2350	S.L.	..	959	1.43	5.75x6.49	1515	6:1	149	7.35:1	.....	.....	.....	.....	ohc	CR. NC. S.	2M	Marelli	Piaggio	.....
Piaggio & C. Societa Anonima	P.X. R.C. 35	A	9	Rad	G	625	2250	11482	..	948	1.51	5.75x6.49	1515	6:1	.....	7.35:1	.....	.....	.474	.016	ohc	CR. NC. S.	2M	Marelli	Piaggio	.....
Piaggio & C. Societa Anonima	P.X. R.C. 40	A	14	S.Rad	G	1000	2200	13120	..	1444	1.44	5.75x6.49	2354	.....	153	7.84:1	.....	.....	.339	.....	ohc	CR. NC. S.	2M	Marelli	Piaggio	.....
Piaggio & C. Societa Anonima	P. XII R.C.-35	A	18	S.Rad	G	1600	.....	.....	.....	1870	1.55	5.75x6.93	3236	6.5:1	143.5	.....	55.5	66.9	.484	.022	ohc	CR. NC. S.	2M	Marelli	Piaggio	.....
Piaggio & C. Societa Anonima	P. XVI R.C.-35	A	9	Rad	G	578	2150	S.L.	87	1474	2.26	5.75x6.49	1515	6.5:1	158	.....	50.23	57.16	.484	.0176	ohc	CR. NC. S.	2M	Marelli	Piaggio	.....

CB.—Carbon steel. CB-NC.—Chrome nickel. Ec.—Eclipse. (H).—Cylinders in H. M.—Magneto. Opp.—Opposed. Rad.—Radial. V.—Vee.

This is the seventh of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME.



"Aviation will harness nature—unite the world"

Says J. CARLTON WARD, President of Fairchild Engine & Airplane Corporation:

"THOSE OF US *who have seen the changes wrought in our world, and in our habits of living, by advances in science and technology, realize that new fields of knowledge being developed by scientists in our laboratories, and applied by our industrial leaders and workers, will bring about still greater changes during the years to come.*

"The art of flying for pleasure and commerce should build vast new industries in all major countries . . . may revolutionize rural life in America during the next decade . . . will write a completely new chapter in man's harnessing of natural forces.

"And the improved transportation, the better communication, the broader understanding that will result from this should create freer, happier lives for the masses of humanity."

• • •

THUS MR. WARD describes the multiple promise of tomorrow's age of flight. But it is a promise which cannot be fulfilled by the aviation industry alone. It needs the support of a waiting "test-pilot market" as well—a market of people who (in business or in private living) are habitually first to accept any change for the better.

This is the market aviation thinks of when it thinks of the more than a million TIME-reading families—people with the foresight, income and influence that aviation needs to sponsor its programs—(people able to support with their patronage and prestige any business which executives now in aviation may enter after the war).

[Believing that the ideas of aviation's leaders are always of interest to the aviation industry, TIME here gives them wider circulation in the name of]

AVIATION'S SILENT PARTNERS

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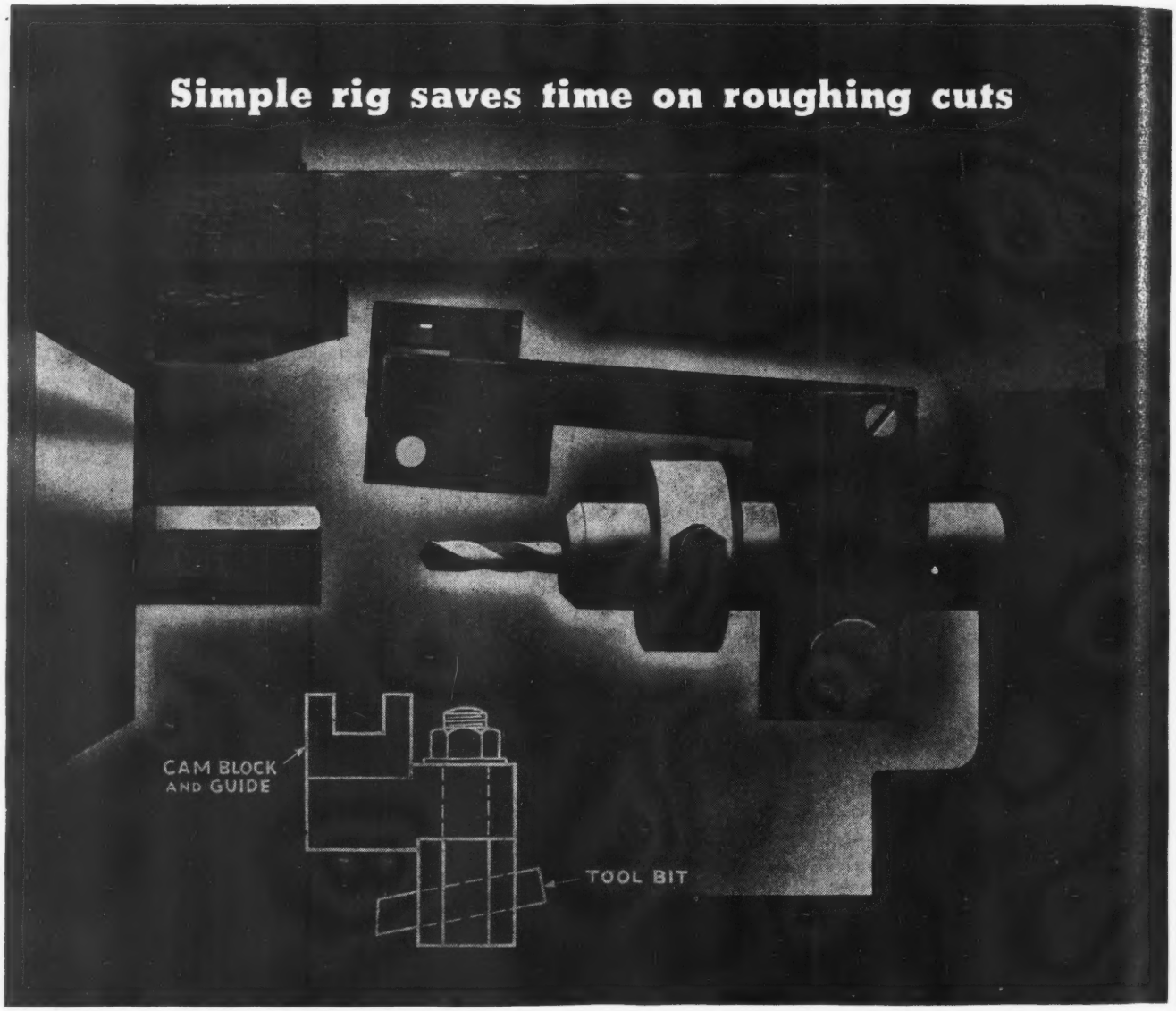
Simple rig saves time on roughing cuts



Information supplied by an Industrial Publication

Roughing tools conventionally mounted on turret lathes or hand screw machines have a tough time cutting hex bar stock. Intermittent cutting, accompanied by successive severe shocks make frequent resharpening necessary. This means equally frequent machine shutdowns.

The problem of eliminating the lost time on such jobs has been solved in a New England plant by an ingenious rig applied to some old turret lathes.

The rig consists essentially of two bars. One, carrying the roughing tool, is pivoted to the turret. The other, having a very simple adjustable cam on its lower side, is fastened between the top of the turret and a sliding support on the headstock.

As the turret advances the roughing tool, the cam feeds it downward, then guides it horizontally and supports it transversely while the roughing cut is made. A drill or other inside tool may be fed in to work simultaneously.

When the roughing cut is finished, the tool is backed off, and the finishing tool fed in on the cross slide. When the roughing tool needs resharpening, it is simply a matter of a few minutes to take it out of the holder and put a sharp tool in. Shutting down is unnecessary. There is less need for expert grinding and resetting.

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Aircraft Hydraulics

(*Continued from page* 133)

Assuming that in the lower seat $A=1$ and in the upper seat $A=2$, we may see that if a 2-lb. spring were used for P, slightly more than 2 psi. would be required to lift the poppet from the lower seat. But since the upper seat area is equal to 2, this psi. would have twice the effective area to hold the poppet against the upper seat. To reset the poppet on the lower seat, the P or spring pressure must overcome the psi. $\times 2$.

As the system pressure reaches a maximum valve, the fluid will pass the open poppet valve H and move plunger R to the right to trip the valve.

The valve described above is becoming increasingly popular, especially with new designs, because in two years of operation it has proved dependable. This valve is essentially designed for 5 gal./min. operation. However, it has been successfully employed at 7 and 8 gal./min. The Electrol company has already designed and satisfactorily tested a larger unit for 16 gal./min. which can operate satisfactorily up to 29 gal./min. with larger port openings.

Bendix Aviation, Ltd., now Pacific Div. of Bendix Aviation, has developed a pressure regulator that meets AN drawing No. 6206 and specification AN-R6. This valve is of the relay or pilot type and has desirable regulating range, quiet operation, and freedom from hydraulic shocks. This unit exclusively employs plastic poppet valves which feature small leakage and sensitivity to foreign particles in the fluid, no tendency to seize at low temperatures, and stability of regulating range at various flow rates.

A cross-section of the Bendix regulator is shown in Fig. 8, while Fig. 10 shows an exploded view of the valve and Fig. 11 is a schematic diagram. By referring to these it can be seen that the unit consists of a cast aluminum alloy body *9* which contains three major ports and a drain port.

The pressure port contains a spring *2* which holds poppet *3* against its seat and returns it after it has been opened by action of the pilot valve. A piston *39* under this poppet is operated by fluid entering its chamber and drained from it by action of the pilot valve. The system port contains a spring-loaded poppet *8* which acts as a check valve, preventing a pressure flow back through the regulator from the accumulator or system, thus maintaining pressure in the system while the pump is unloading through the regulator. The third port is the return, directly connected to the reservoir with a minimum restriction.

This valve, like the Vickers unit, contains a drain connection from the pilot valve so that system back-pressure does

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not affect the pressure regulation setting, hence chattering and shock are prevented. The pilot valve, fastened to one side of body *9*, consists of a spring-loaded piston *27* which can be adjusted for pressure setting by turning the driver pin *18* on the tip of the valve housing to regulate the loading and unloading pressure. A spring-loaded poppet *43* located in bottom of pilot valve is forced off its seat by piston rod *32*.

Top of the piston in Fig. 8 is open to pressure from accumulator and communicates with the chamber under pilot poppet by drilled passages through the valve. Passage between upper end of poppet seat and pressure poppet operating piston *39* allows pressure to flow between these chambers. Piston *32* is drilled along its axis and cross-drilled so that return oil can flow into the spring chamber and out through the drain port after the piston is moved from the pilot poppet. Note that this poppet valve is in reality double, one face sealing the system pressure from the pressure unloading valve unit, the other face sealing pressure from the drain connection in the piston while it is holding the first sealing surface off its seat.

In Fig. 8, fluid enters the valve through pressure port *1* and passes through check valve *8* into accumulator and system. Poppet *3* prevents flow to return port. This fluid is also conducted under the pilot poppet *43* and on the back of the piston *27*. As pressure in the accumulator builds up, it is transmitted to the piston *27* which moves downward against the resistance of spring *31*. When this pressure reaches cut-out point, the upper face of the double pilot poppet *43* closes drilled passage in piston rod *32*, which pushes the second face of the poppet off its seat The fluid under accumulator pressure is thereby directed under pressure piston *39* which raises the pressure or by-pass poppet *3* wide open.

At this time the total fluid flow from the pump is by-passed around this open valve through the return port *42* into the reservoir The check valve *8* is seated by accumulator pressure, preventing back flow into the valve and maintaining the cut-out or unloading pressure in the accumulator and hydraulic system When pressure in the system is released by actuation of any of the units or when this pressure drops due to internal leakage to a pre-determined value, pilot spring *31* pushes the piston *27* back. The double pilot poppet is then seated on its lower face, stopping the flow of oil to the by-pass piston *39*. While piston rod moves back, the upper face of the poppet is unseated from the drilled passage in the rod. The fluid under the by-pass piston is released through the pilot piston rod into the spring chamber and out through the

drain. At this position the regulator is out into the loading position, and the system receives fluid under pressure from the pumps.

Generally speaking, the Vickers, Electrol, and Bendix regulators accomplish the same result. However, method of accomplishment is entirely different in each case.

America at War

(*Continued from page* 111)

matched in technical creativeness for either to hurt the other much with gadgets. In the Jap war, it's different. They are being hurt now by Yankee devil machines which they know nothing about, according to Navy Secretary Frank Knox. One more note on the invasion: Success depends more upon the chosen leaders than anything else. President Roosevelt's appointments of officers to head up the job are approved everywhere. Where teamwork has been developed by association, he has avoided disrupting it. In this country, there is his own staff—Gens. Marshall and Arnold and Adms. Leahy and King. In Europe, Gen. Eisenhower was allowed to take Gen. Doolittle with him to England.

AAF headquarters in Washington was quick to correct any impression that Gen. Eaker was in any way demoted in his shift to the Mediterranean. Gen. Eaker is the world's best authority on strategic daylight bombing, and there is every reason to believe that this type of attack will head up from the south. The weather and geography both favor it. Besides, it is easy to guess that the entire topside of England will be occupied with other matters.

Appointment of Air Marshal Sir Arthur Tedder as deputy supreme commander under Gen. Eisenhower is the highest trust yet extended by the Allied Command to an air officer. Tedder, a keen forward-thinking little Scot, won this confidence by beating the Luftwaffe in Africa and by helping Montgomery push Rommel into the sea.

Secretary Knox says that the groundwork is done and that the big battle of Japan is about to be initiated. The President said in his report on the three-power conference that the Nippons will be pounded and worn down as much as possible while we are still busy with Germany.

The Japanese leaders still feel that the war is far out on the rim of their captured world, but they sense the power of the Allied attack. Several times recently they have admitted to their people that they are not in complete control of the situation. Again and again they admit the superiority of Anglo-American aviation.

Japan has lost considerable of its

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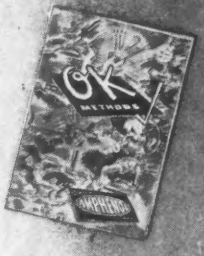

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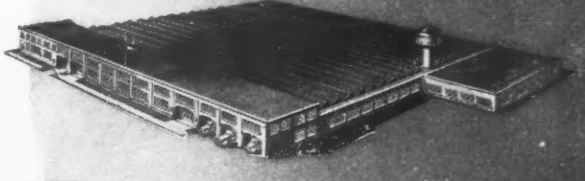

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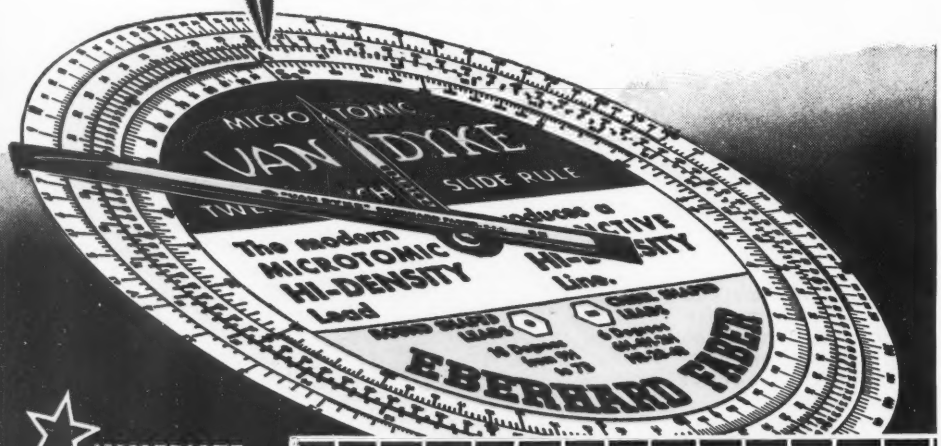

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aviation, which appears so far to have been replaced at the rate of loss or better. The Nips have lost a number of navy ships, particularly cruisers and aircraft carriers, which are slow in replacement. Their merchant shipping is definitely on the down grade, as proved by their increasing use of barges, which are slow and expensive in loss of men. Their loss of territory so far hurts them only in that it dampens their invincibility.

The Battle of Japan has been prepared. Adm. King says studies have been under way for several months looking to the shift of power from the European theater to the Pacific theater, not only when Germany is defeated but when her defeat seems near at hand. The main lines of attack on Japan are already determined and additional means will be used to implement the general strategy. The Admiral said that the Allies never intended an island-by-island hopping campaign, that present operations suggesting such an approach are merely due to current limitations.

The President squelched the clamor for Russian bombing bases by pointing out that if the Soviet gave them to us now, the Japs would take them immediately—unless the Russians diverted military strength to defend them. More goods are now going into China by air than ever went over the Burma Road before the Japs took it. But it is not enough, and probably never will support an air attack from China. The British so far have made no progress in clearing the enemy out of Burma. There is no ground yet in Allied hands from which the Jap homeland can be effectively hit by aircraft.

Here in America, airplane production is rolling prettier than ever. Numerically it is climbing on a long slope from 9,000 per month, but will not much exceed 10,000. The program for this year calls for not many over 100,000. But tonnage will increase greatly, due to emphasis on heavies, now coming out at more than 1,000 per month.

The quality of practically all military airplanes is now tops—equal to, and preponderantly better than, any the Germans have. There is no doubt the war could be concluded with standard equipment now in action, but the head men are taking no chances. They are coming out with new and better designs in all categories.

Three planes have attracted special attention as this Communique goes to press. One is the Curtiss-Wright SB2C-1 *Helldiver*. After numerous design changes like those which have plagued the development of other airplanes, the company has the satisfaction of high praise from the Navy for brilliant performance of the SB's in initial action against the Jap at Rabaul. In fact, Navy claims this diver as the star in its troop of dive, pursuit, and torpedo equipment.

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When bomb bay doors "open for business" over Nazi industrial centers, it's a good bet that some enemy factories will be "closed for repairs" for some time to come . . . perhaps forever. These telling blows are being delivered on schedule by American bombers in a perfect demonstration of teamwork and technique.
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The second airplane in the late spotlight is Boeing's *Sea Ranger*, sometimes dubbed the *Lone Ranger*. This two-engine long-range, champion lifter was accepted a year ago, but it had been left out of the production schedule because all facilities were tied up. Now, however, Navy is trying to find plant capacity to turn it out in volume. Boeing of course would like to build it but cannot be excused from "heavy" duty.

Third is Martin's famous *Mars*, which has just made the longest hop, lifted the heaviest load, and picked itself up as the heaviest gross airplane weight in history. Performance was excellent and Navy now wants mass production.

No definite conclusions have been reached on the large questions of converting plants to peace work, on termination of contracts, or on disposal of war surplus equipment and manpower. Congress went home for a nice long vacation, leaving these jobs undone.

But many hard problems *have* been solved—too many to mention. Aircraft materials and components are done up as brown as a biscuit. Manpower is much better, maybe as good as it will ever be.

Securities Gain

(*Continued from page* 119)

values. Boeing's common stock, on the other hand, is currently selling at one-half of its indicated book value. Almost the same ratio applies to the common stocks of Curtiss-Wright, Douglas, and Martin.

Carrying this analysis a step further, it is pertinent to note that a leading statistical service estimates Glenn L. Martin as having working capital equivalent to more than $15 per share—or approximately the present price of its stock. Similarly, this same source places Boeing's working capital at over $9 per share—or moderately below its existing stock quotation.

This favorable asset position now existing for the aircraft industry, however, is subject to a serious question mark. So much is dependent upon the nature of ultimate renegotiation processes and contract termination procedures that an ill-conceived government policy (a sound one is not yet in evidence) can seriously impair any semblance of financial strength now peculiar to the aircraft group.

'43 Miracle Doubled

(*Continued from page* 114)

translate the heavies back into smaller-plane units, they'll then realize that 1943 gave them their 100,000 planes and more to spare—in that manner of speaking.

Between January and December, airframe poundage more than doubled, the month-to-month rise averaging 3,600,000 lb. December's peak production of the year was figured by the statisticians as 2,374,193 lb. per day or 1,648 lb. per minute.

The human terms of such remarkable production should be given attention. Output per employee gained some 60 percent in '43, and the WPB figured average monthly airframe weight produced per employee at 60 lb. in 1943. Contrast this with the average of 28 lb. in '41. Employees in the industry totalled 1,600,000-plus in 1943, comparing with 48,000 in '38, and the year saw more than twice as many women employed in aviation as in 1942. It is further stated that 1943's outstanding production was accomplished with only a 50 percent increase in plant area and only a 45 percent rise in employees.

Dollars

By their very nature, the value figures of aircraft production defy such precision as may be attained in reckoning units and pounds. However, the WPB's computations may be considered pertinent, since they offer logical breakdowns for the last two years. According to this source (see Fig. 3), 1943 dollar

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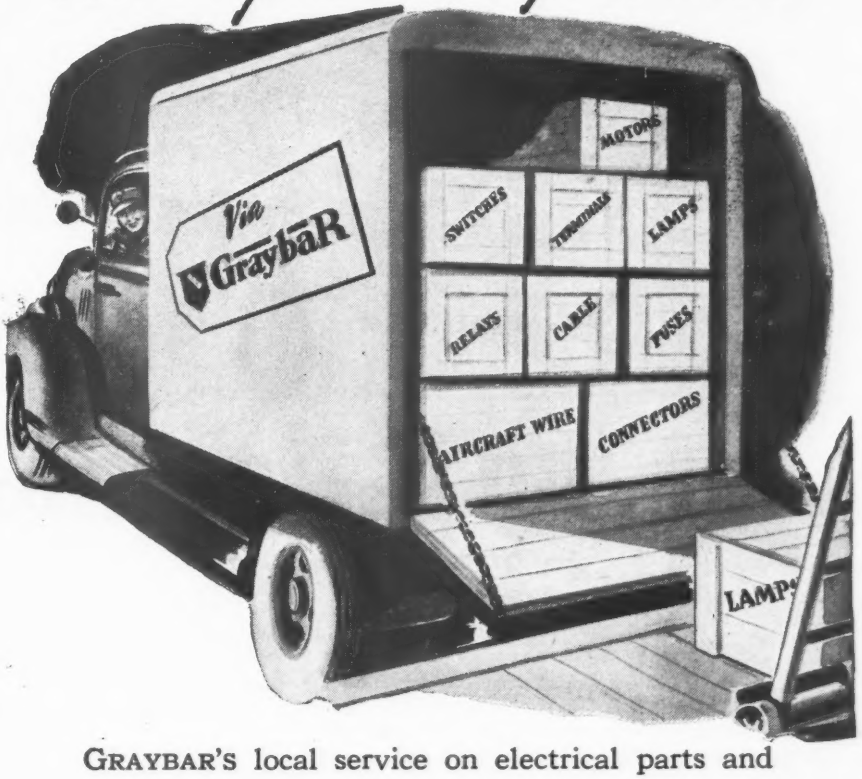

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value totalled $14,900,000,000—a summing up of 7.2 billions of dollars in airframes, 4.2 in engines and propellers, and 3.5 in spare parts. This was better than double the comparable figure for '42, when the total was judged to be $6,300,000,000 (airframes 3.0 billions of dollars, engines and propellers 1.2, and spare parts 1.1). Production in '41 was rated at $1,750,000,000, with no adequate breakdown available.

True, different dollar figures for 1943 have been publicized. Most common is the reference to the current industry as a $20,000,000,000 business, and it is likely that this makes sense if every single item over and above planes, power plants, propellers, and spares were added, in dollar terms, to our 14.9 billions. For instance, a single aircraft field-maintenance unit often costs $75,000 and more. But in accord with our related portrayal of units, pounds, and dollars, the 14.9 becomes more satisfactory. The latter figure represents a 751 percent rise over '41, and how far we have come since the prewar days is emphasized with the mention of the 1939 total—$200,000,000.

A comparison over the years of the dollar figures with the airframe weight calculations bears out the trend of more poundage of aircraft per dollar, readily understandable in view of the many new efficiencies, shortcuts, and increased labor productivity.

Foreseen in '44

Many factors make calculations of the immediate future's production difficult. For one thing, our military leaders see Germany folding in 1944, and with the weight of our arms then thrown against Japan, various changes in planes would be called for to meet the differing conditions on Far East battlefronts. Moreover, some planes would be discontinued, and certain new types would be projected. All this would have a definite influence on 1944 units and pounds performance.

And in judgments of 1944 dollar values, the $2,000,000,000 cut "by modification and possible deferment of a portion of the airplane program" must be primarily figured, along with such considerations as renegotiation of contracts and termination factors. New economies of production will, moreover, bear their greatest fruit in 1944.

Even so, our Fig. 3 includes rough 1944 estimates in the three categories. The 110,000 planes (forecast by T. P. Wright, of the Aircraft Resources Control Office) would be turned out with a monthly production of but 9,166 craft—only 364 more than December production. This may raise the eyebrows of those who see the industry charging ahead to a 12,000 monthly output. But again, big bombers, especially such craft as the Boeing B-29's, supply the

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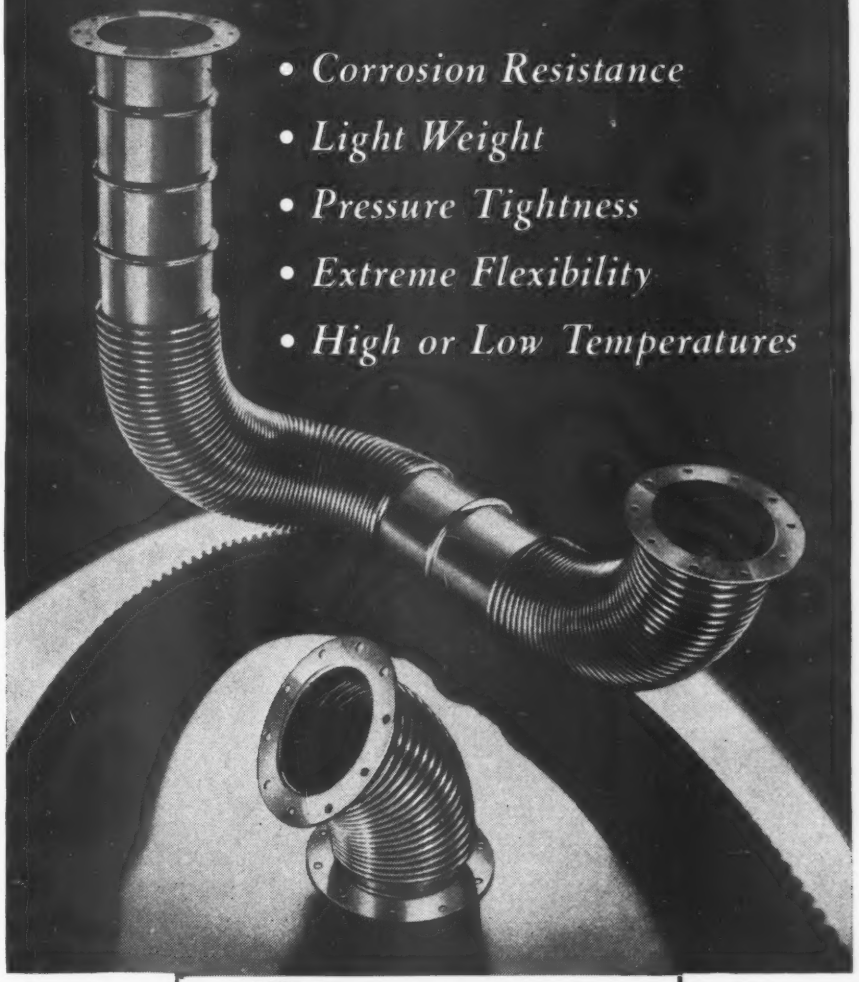

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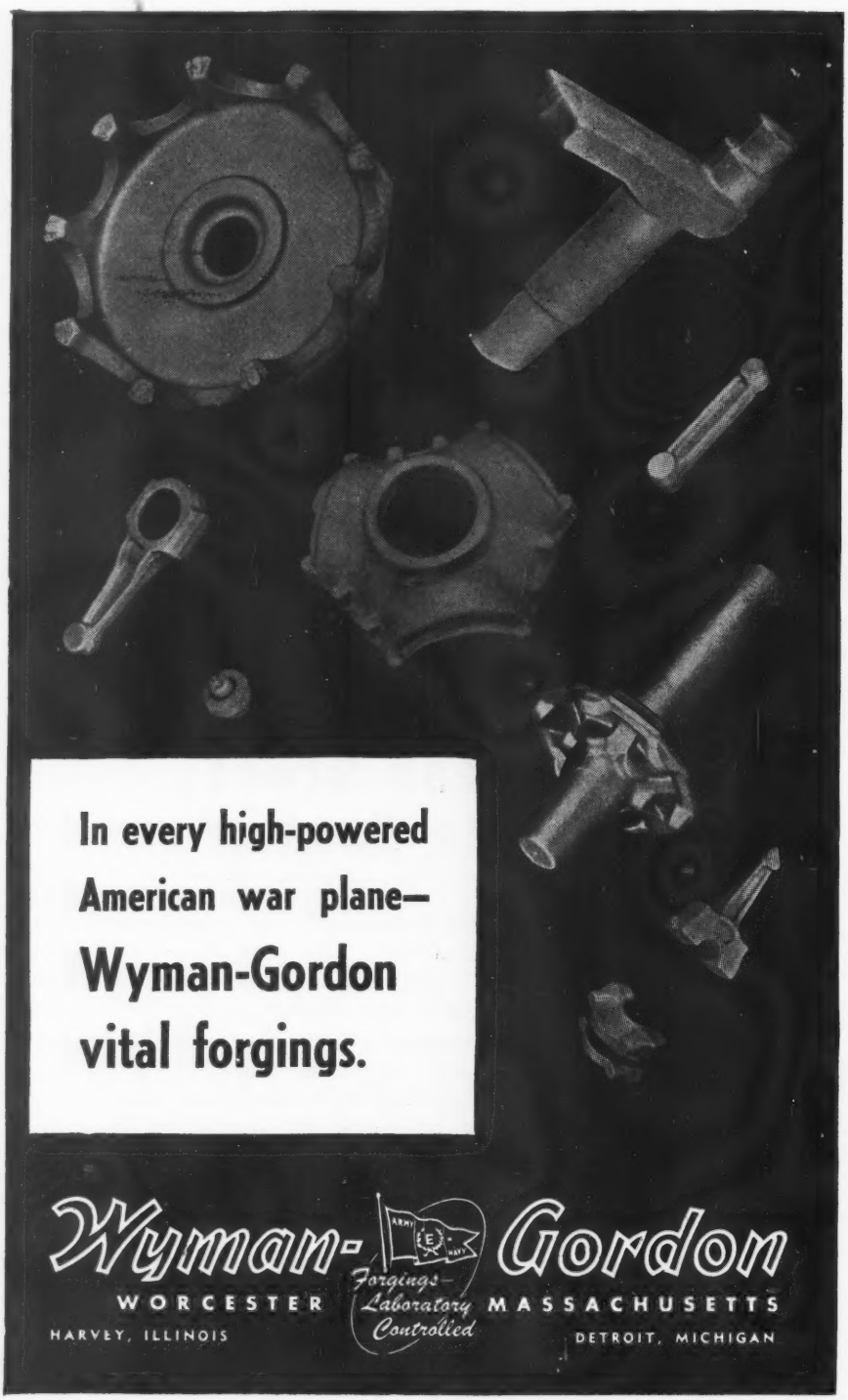
answer. Once more it's the translation from units to pounds.

Accordingly, the 1944 airframe figure has been judged by Wright at 1,009,000,000 lb. And our own dollar figure is $23,000,000,000, a value achieved through relation with the '44 estimated airframe weight in Fig. 3. We repeat, however, that these various projections may quickly go awry due to potential developments of this new year which can hardly be pre-gaged.

Speaking again of units, Gen. Arnold stated on Jan. 1 that 145,000 planes were scheduled in the next 15 mo., and this program would divide out to a figure not much above our 1944 estimate.

Further notes: Airframe production in 1944 is expected to be four times that of 1942, and an average airframe weight surpassing 9,000 lb. is seen, a 638-lb. rise over the December figure. Counting spare parts, a 10,000 lb. average weight is forecast.

Superbombers are to reach big output, as are also long-range fighters and cargo craft, and the total combat plane production will come pretty close to covering 75 percent of the total '44 output, as training craft turn-out becomes for the most part a matter of replacements.



Company Accomplishments

Turning now to the fine records made by individual companies and groups of companies, let us first laud the many goals won through the programs of the AWPC East Coast, AWPC West Coast, and their new national body. A huge total of 24,566 planes was the record of the East Coast Council members in '43, scaling an airframe weight of 180 million pounds, and computed at a dollar-value total of approximately $2,225,000,000. In the last four-and-a-half months of 1943 they constructed more craft than in the full twelve months of the previous year. The members: Aviation Corp., Bell, Brewster, Curtiss-Wright, Eastern Aircraft of GM, Fairchild Engine & Airplane, Martin, and Republic.

Record of the West Coast Council members was 26,636 warplanes, an increase of more than 50 percent over '42, while the airframe-weight "up" was put at more than 72 percent, this higher figure representing the boost in bomber production. Reporting new manpower utilization efficiencies, AWPC West stated that whereas the equivalent of 70 employees working one year was required to produce a four-engine bomber at the time of Pearl Harbor, today the same plane would be constructed in one year by but 17 workers.

Meanwhile, a production expediting committee was announced as the newest AWPC West unit. This committee, composed of top aircraft men, now acts as a "task force" to help iron out production problems of the member companies—Boeing, Consolidated Vultee, Douglas, Lockheed, Northrop, North American, and Ryan. West Coast plants were particularly plagued by manpower shortages, and their outstanding successes in the face of these difficulties is worthy of especial praise.

At the end of the year, new high outputs of eight types of planes were particularly noted by the WPB. The planes and producing companies were: B-17 *Flying Fortress*, Boeing, Douglas, Lockheed (Vega); P-38 *Lightning*, Lockheed; B-24 *Liberator*, Consolidated Vultee, Douglas, North American, and Ford; F6F *Hellcat*, Grumman; SB2C-1 *Helldiver*, Curtiss-Wright; P-51 *Mustang*, North American; TBF *Avenger*, Grumman, and Eastern Aircraft of GM; and C-46 *Commando*, Curtiss-Wright.

Further a special Navy release praised seven companies for being either on, or ahead of, schedules—Chance Vought of United, Douglas, Grumman, Consolidated Vultee, Martin, Lockheed (Vega), and Eastern Aircraft of GM.

At press time, the full sheaf of individual company reports on '43 production was not yet available. However, enough statements had been received to offer an exemplary cross-section, and

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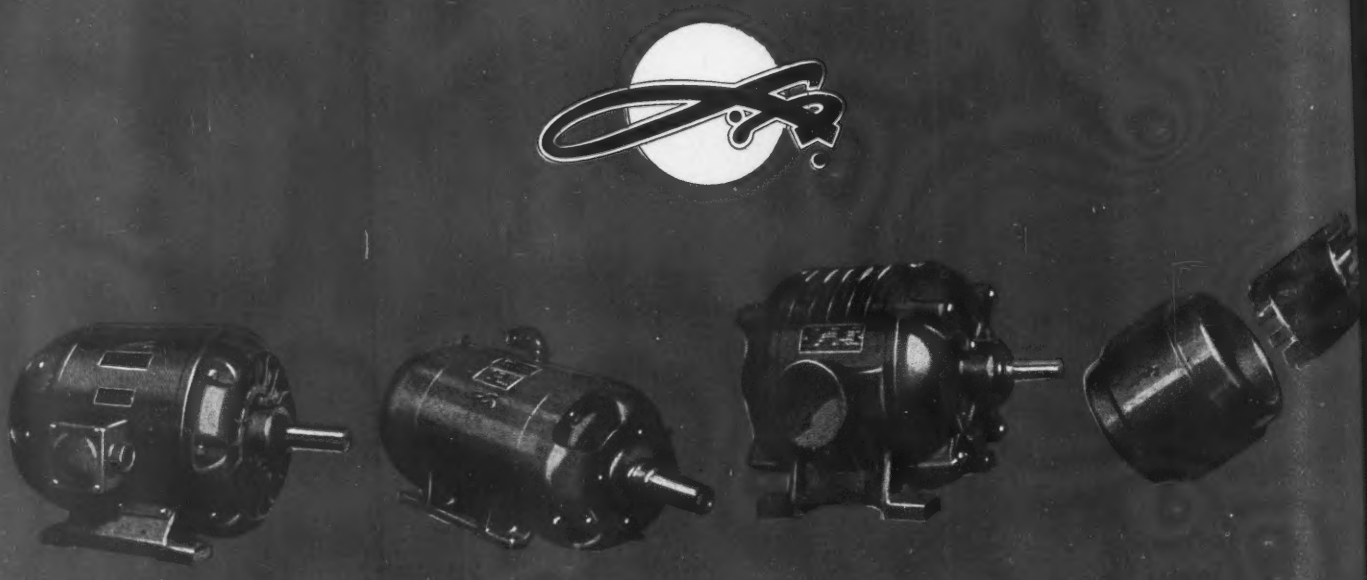

these are briefed in the following paragraphs:

BEECH AIRCRAFT CORP.: While facilities were not substantially increased during fiscal year ended Sept. 30, value of deliveries doubled over previous year and were 15 times those of fiscal 1941. After negotiated refunds and provision for additional refunds for fiscal year 1943, totalling $29,534,438, sales amounted to $97,043,946.

BOEING AIRCRAFT CO.: *Fortress* production was 146 percent ahead of 1942. December output was highest in company history—92 percent ahead of the previous January, and ten times that of Nov. 1941. B-17's are being completed in one-third the man-hours required when the war broke out. Since then costs to the government per plane has been halved despite design changes, and wage rates have increased 27 percent since Pearl Harbor.

CONSOLIDATED VULTEE AIRCRAFT CORP.: "In 1942," reports Chairman Tom M. Girdler, we "delivered around 53,000,000 lb. of airplanes, including spares. In 1943, we multiplied this almost two-and-a-half times; we made a total of well over 126,000,000 lb. of planes. . . The WPB compiles comparisons for all aircraft plants in terms of pounds of planes produced per man per day. It reported a national daily average of 4.8 lb. of plane per man, for the three months ending October, in all plants producing heavy bombers. The figure for Consolidated Vultee's San Diego plant was almost twice as high; the WPB report put it at 8.3 lb. . . We are now producing 14 *Liberators* for the same direct labor that built only one three years ago." Vultee Field Div. of Girdler's company at the end of the year completed its 10,000th *Valiant* basic trainer.

CURTISS-WRIGHT CORP.: Eleven months' report on airframe production showed an increase to 40,353,352 lb.—56 percent over the corresponding 1942 period. November airframe weight alone was 5,000,000 lb. above all of 1939. . . Propeller Div., cited by AAF for quantity manufacture of hollow steel blades, developed automatic engine speed synchronizer and began perfection of thrust meter to measure horsepower. Several conveyor systems were installed in propeller plants. . . The 10,000th P-40 was completed.

DOUGLAS AIRCRAFT CO.: Deliveries of combat planes reached 96,446,000 lb., valued at $1,000,000,000. . . Unit costs to government were reduced 22 percent and man-hours on *Fortresses* 71 percent. . . Output was 204 percent ahead of 1942, but maximum is not expected to be reached till summer, when two Oklahoma plants and $33,000,000 Chicago factory "come in." Then employment will reach 200,000.

EASTERN AIRCRAFT DIV. (General

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REPUBLIC AVIATION: Reported P-47 production schedule easily met.

WRIGHT AERONAUTICAL CORP.: Eleven month's report showed monthly rate of production 3,000 percent over volume of Sept. 1939. This 1943 output is expected to be doubled this year. Mass-manufacture began on 2,200 hp. model, raising power of average engine from 1,335 hp. in December, 1941, to a current 1,655.

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NASH-KELVINATOR CORP.: Production of 2,000 hp. P & W's went higher, Hamilton Standard propellers were turned out at a rate ten times that called for in the initial contract, and facilities were made ready for mass construction of R-6 Sikorsky helicopters for AAF.

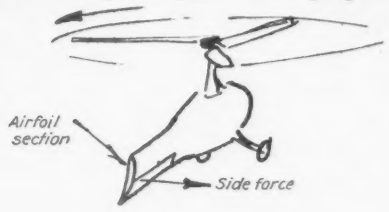
PACKARD MOTOR CAR CO.: Value of Rolls Royce engines for aircraft and PT boats was $355,000,000, one and a half times highest figure of automobiles for any peace year.

Helicopter Hurdles

(*Continued from page* 115)

sume its proper role in aviation history, and I firmly believe that the fastest and most direct way to the perfection of any aircraft is in actually building the craft to fit the specific fields for which it is intended. Only then can the needs be confronted as they appear, thus to discover the problems involved in meeting those needs. It is with this in mind, therefore, and not merely as criticism of progress which should elicit only praise, that I offer these considerations toward a better understanding of what has been accomplished and what still remains to be done in the way of refinement and modification.

To return, then, to the first of these problems—power-plant and propeller



Torque-Compensating Vane (Haffner)

combination: Though solved relatively early in helicopter development, there has never been offered a final and conclusive solution. This is due not so much to the problem itself but to the adaptation of its solution in driving a propeller that becomes, in effect, a lifting and controlling surface as well as a means of propulsion.

It is obvious that in driving a rotor directly from the engine, there will be a torque applied to the fuselage equal and opposite to that of the rotor itself. The adaptation of the power plant-propeller combination of the airplane was simple enough, but the solution of the torque reaction involved was another matter, and it remains today one of the most

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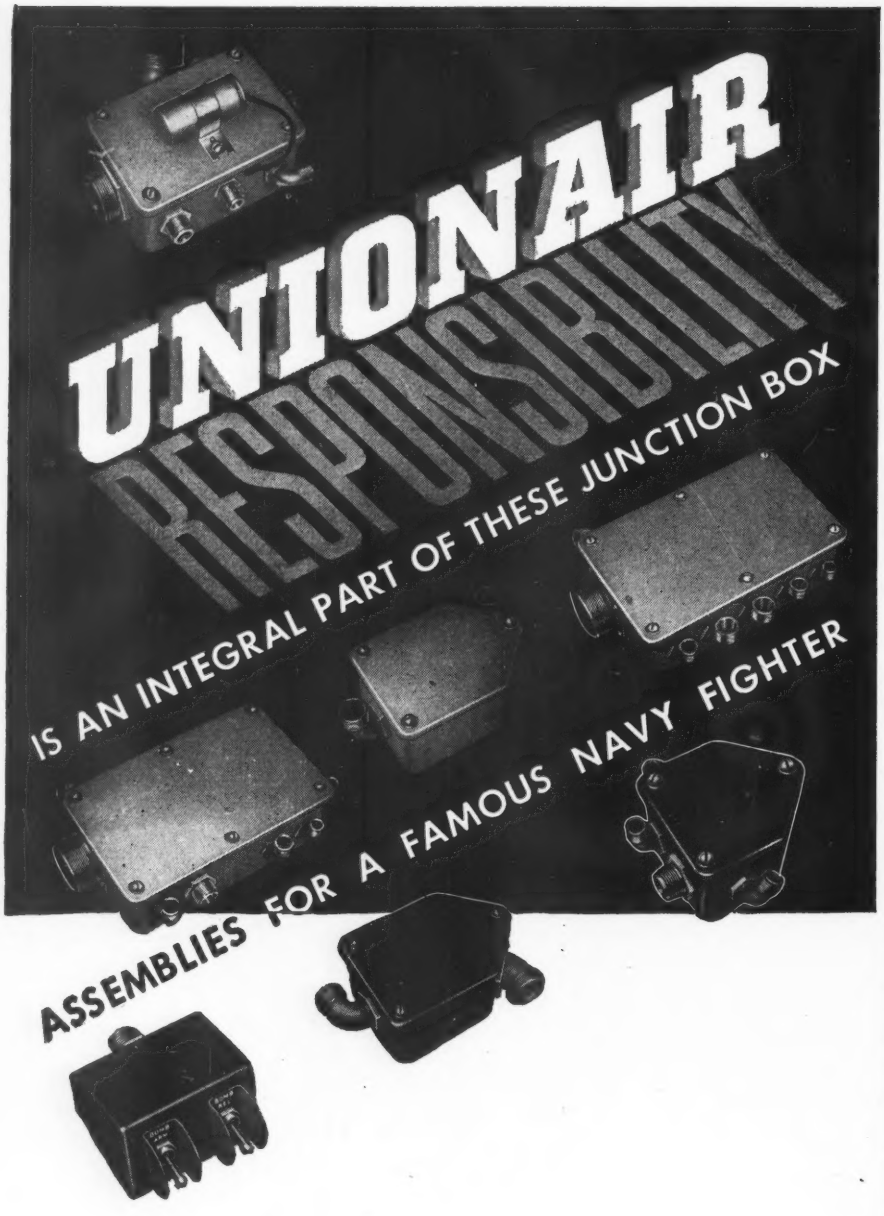

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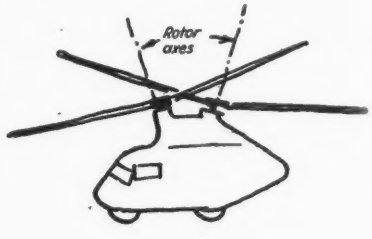
vital and strongly contended problems confronting the whole helicopter picture. This is chiefly because there are so many modifications possible, each with its own advantages and disadvantages.

Theoretical solutions are no less hotly advocated than those already proven

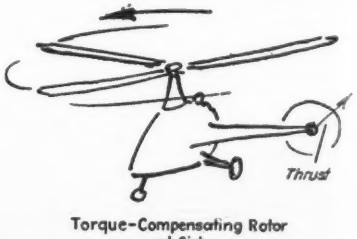


Flettner Mesh

practical, and in many cases they are equally logical and seem equally feasible. Which will ultimately prove to be the final answer has not yet been definitely determined and until it is, much of the helicopter's full potentiality will inevitably be squandered in the stubborn persistence of each for his own. I personally believe that the solution lies somewhere in the combination and modification of several approaches, but let us examine each in its own light objectively, weighing the good and the bad points against each other—

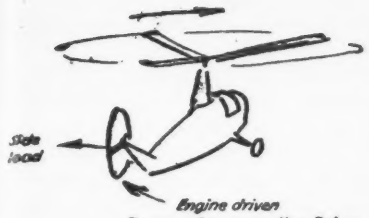
The single-rotored machine has much to recommend it in simplicity of design and mechanism. It is a small ship in comparison with other types, and the smaller number of blades make it more economical to build and operate. However, a single rotor, must of necessity be relatively larger in size, and the tendency of larger rotors has always been toward roughness and vibration. Also, it cannot allow much freedom in location of the C.G., which has always been one of the major disadvantages of the control method in rotary wing aircraft.

In large transport or cargo ships this would be a serious obstacle. The chief



Torque-Compensating Rotor at Side

difficulty of the single rotor lies, however, in finding an efficient method of torque correction. Creation of a counter-

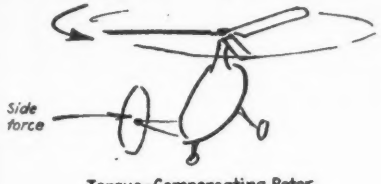


Torque-Compensating Rotor at Tail, Engine-Driven (Sikorsky)

acting moment by use of a small auxiliary propeller placed at right angles to the rotor has been done successfully by the Sikorsky machine with a certain amount of power loss. This is a none too efficient method of directional control, for it serves to create a conflict in control operation. When power is varied to the main rotor, changing the amount of torque, a compensating correction must be made in directional control, which then affects the lateral thrust of the auxiliary propeller and necessitates another lateral correction.

This is, extremely confusing to the beginner regardless of how much experience he may have had in other types. At best it is a compromise, neither eliminating nor using this adverse force but striving rather to overcome it by working against it.

Another type offering a similar solution would place engines or propellers in the blades themselves, resulting in a large whirling mass with high forces,



Torque-Compensating Rotor at Tail, Autorotative

untold mechanical complexities, and few if any, advantages save the one of eliminating torque at its source.

Still a third adaptation proposes use of streamlined vanes on the fuselage. This, as far as I know, has never actually been worked out as a practical solution. It necessarily would create a high amount of drag and consequently cut down the efficiency of the ship as a flying machine. Moreover, it would not have sufficient flexibility to meet the needs of varying conditions, for the amount of torque correction necessary varies with the power applied to the rotor, the attitude of the ship in maneuvers, and the rotational speed of the blades. It stands to reason that the correct setting for such vanes in vertical descent or hovering will not be equally efficient in forward flight, in backing up, or in turns. No fixed structure appended to the fuselage of the ship can possibly meet these varying conditions.

Consequently, this not being a sufficient solution in itself, it seems pointless

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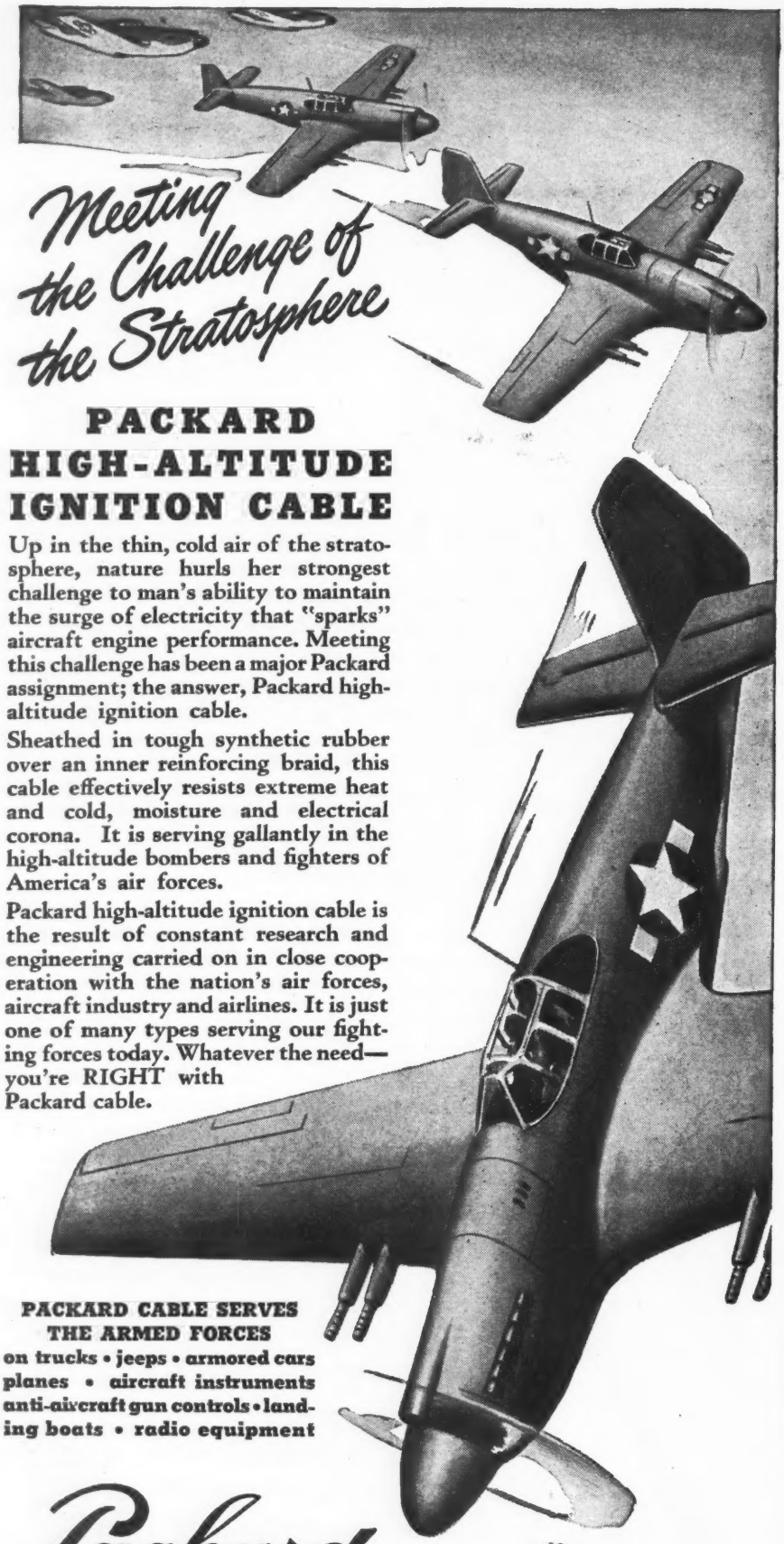

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to discuss further whatever other advantages or disadvantages this proposal may offer.

Then there is the co-axial type, mounting two or more rotors on the same shaft and having almost the structural and control simplicity of the single rotored machine. Here, however, there is the disadvantage of requiring double rotors

Torque-Compensating Jet

to accomplish the work of one since the disk area of both can be only as great as the disk area of either rotor alone. There must necessarily be a certain amount of interference between the rotors, since the airflow through the lower blades is continually disturbed by the upper rotor. At best this is a clumsy solution structurally, involving much mechanical complexity and the necessity for sufficient space between the rotors to allow for the flapping of the blades in translational maneuvers.

Most successful form of this solution to date has been the use of opposite rotating rotors placed laterally. This eliminates any interference between the rotors and increases the disk area, since each rotor is lifting independently of the other. It allows the use of smaller blades, thus cutting down some of the roughness inherent in the larger rotors. But it increases the mechanical and structural complexity of the machine as a whole, the control mechanism, and the over-all weight and span of the ship. It is a far more intricate and expensive ship to build and to operate. Still it has a large amount of inherent stability which many of the other types lack, and it opens the way for expansion in size and in load carrying capacity.

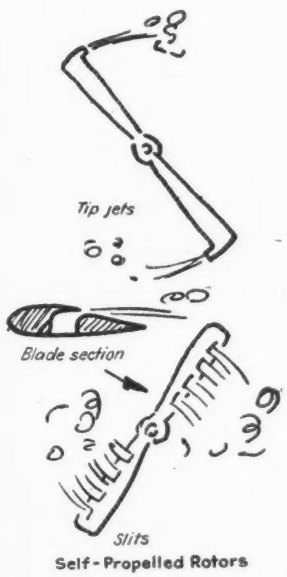
There are, along the same lines, such modifications as synchronized overlapping rotors either laterally disposed or placed in tandem. The individual advantages and disadvantages of such modifications follow the general trend. What is gained in lowered drag, and compactness from overlapping is lost, at least in part, in aerodynamic interference and reduction in disk area. Chief advantage in placing the rotors in tandem would seem to be the elimination of the lateral booms, though there seems to be (in my experience of lateral translational flight with laterally disposed rotors) a great possibility that tandem rotors may greatly increase the inherent stability of the ship as a whole and simplify the lateral control.

It is difficult to say where jet propulsion may lead us in the future development of the helicopter because at this

writing comparatively little of its possibilities has been publicized. Theoretically it is an ideal solution. It eliminates torque at the source and has all the advantages of the single-rotored machine plus the possibility of using as many rotors as may be desirable without adding to the mechanical complexity of any of them.

There have been two main methods advocated—the small-mass high-speed jet propulsion which uses small jets at the tips of the blades, and the large-mass jet propulsion proposed by Stalker, using a long slot or series of slots down the length of each blade. Both would achieve rotation of the blades without direct drive of an engine. The disadvantages of the former are, of course, the high energy loss due to high jet speed in relation to rotor speed, also the great heat generated by the burning gases. The latter method has a low kinetic energy loss and boundary layer control, but it loses in efficiency by necessitating a blower and ducting system.

The problems involved in either system have not yet been sufficiently worked out to show just where we stand with this type of solution because as yet no helicopter has been built with this type of motive power. One of the chief difficulties discovered to date has been the fuel consumption incident to the use of jet propulsion—it runs three to four times higher than that of the gasoline engine. Moreover, in the application of this idea to rotary wing



Self-Propelled Rotors

aircraft, we must take into consideration the characteristics of the blades themselves in rotational flight and the effect this method of propulsion may have on such items as blade torsion, the relation of C.P. to C. G. location and travel, pitch change, etc.

Whether the advantages will outweigh the disadvantages, we shall not

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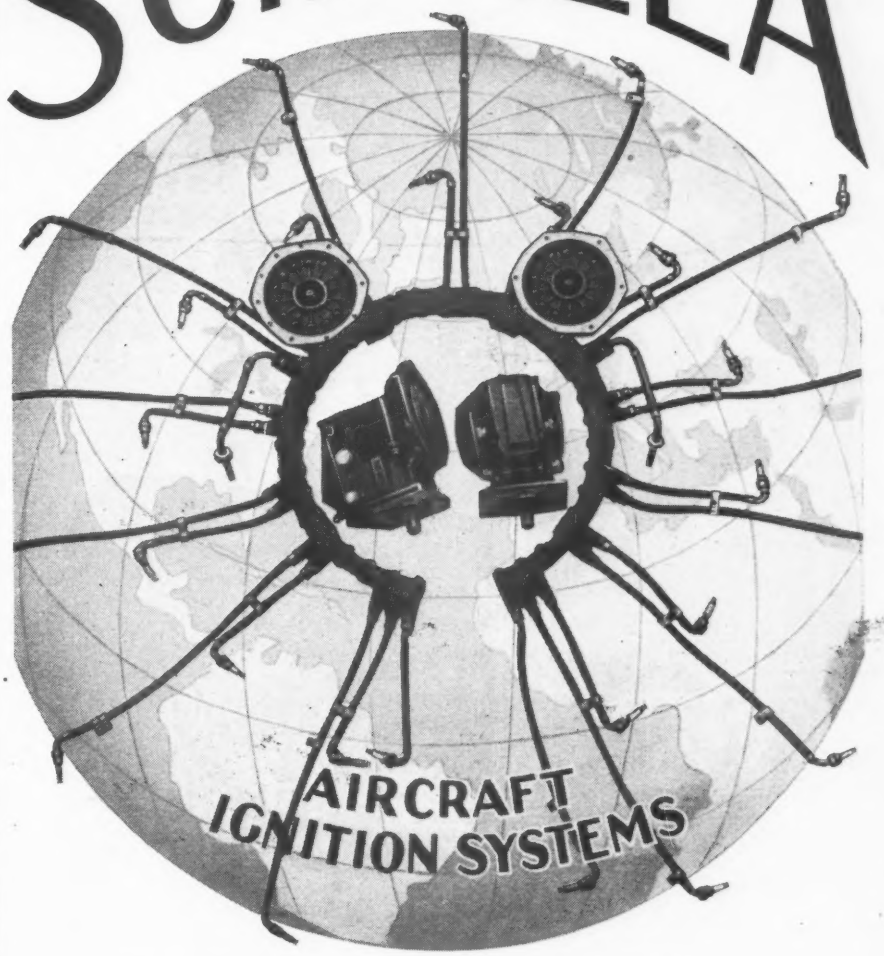

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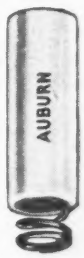

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know until we find more definitely what problems we shall encounter. However, there has been a great deal of research done already, and the knowledge and information gained have brought us much nearer a solution than is yet generally realized. How effective that solution may be, however, is known (if it is known at all) only by those who have been doing this research, and until it becomes a less closely guarded secret, we cannot know what the efficiency will be in comparison with other types.

These, then, are the solutions, both practical and impractical, that have been offered to date. Somewhere among them lies the ultimate direction helicopter development must take. Barring jet propulsion, which may or may not be the final answer, we have followed each to its logical conclusion and found in no one of them the whole or final answer. It is my personal opinion, based on many years of experience with all types of rotary-wing, that we shall not find that solution until we can combine the simplicity of the single rotor with the efficiency and stability of the multi-rotored craft. Otherwise we shall be continually working against the disadvantages of both.

No doubt an ultimate answer will be found. The helicopter has come too far to be discarded now for want of a little added refinement and modification, but it will take the earnest effort of many skilled men working together, not the isolated discoveries of a few working in secrecy and jealously guarding that secrecy, to bring this about—just as the airplane has ultimately become the product of no one man or group of men, but of a whole generation working competitively but in cooperation toward a common goal.

I do not predict that the helicopter will one day replace the airplane. Neither can I say that it will not. But this much is certain: There is a need for this type of flight that the airplane has not filled and will never be able to fill. When we have found the final answer to these basic problems confronting the helicopter—and that time, I believe, is not far off—the other lesser problems will fall into line more or less automatically, and we shall then have a machine that will incorporate a new phase in aviation history.

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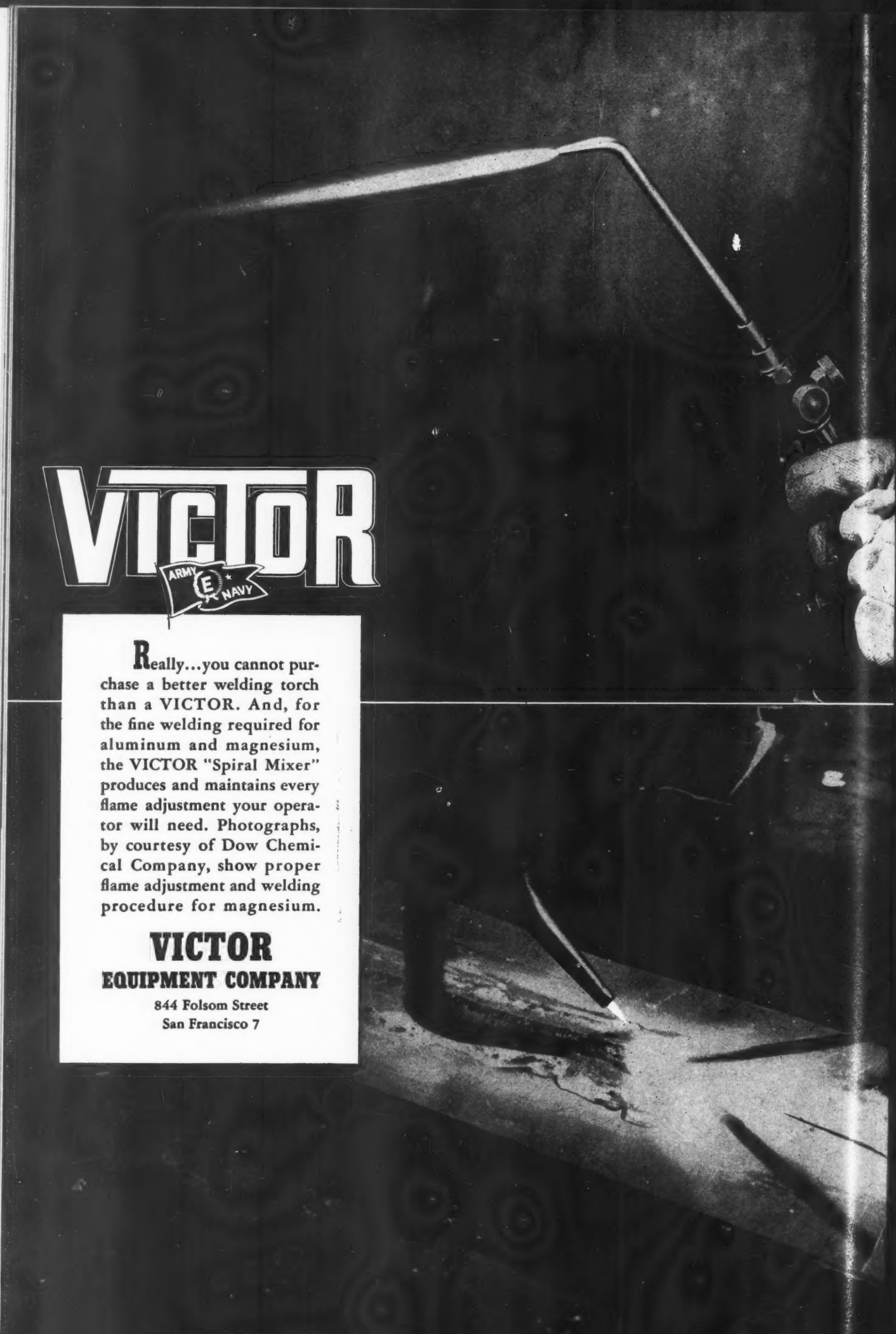

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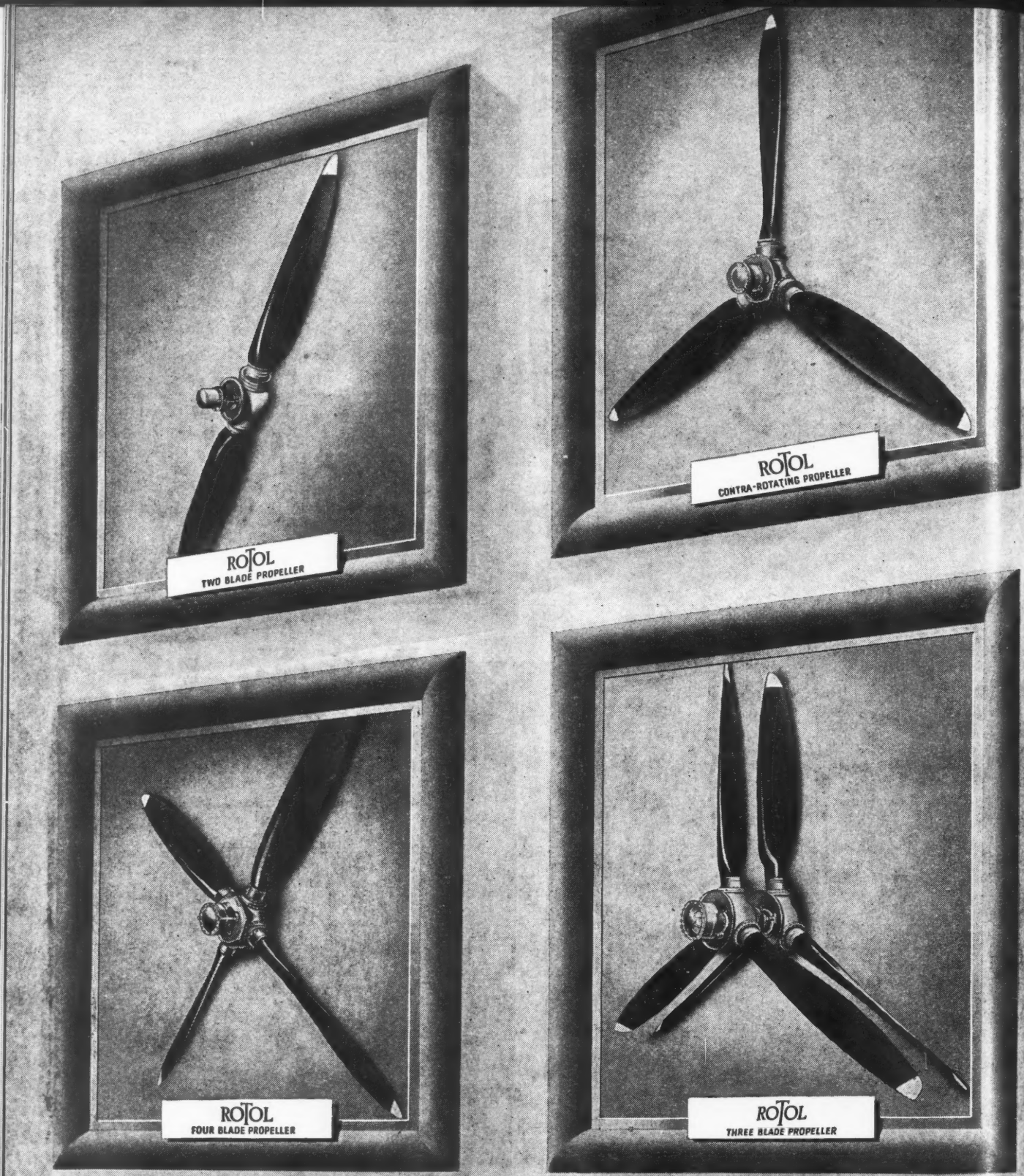

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Glider Manufacturers

Allied Aviation Corp., N. Hollywood, Cal., (see Aircraft)

Allied Aviation Corp., Baltimore, Md.

American Aviation Corp., Jamestown, N. Y.

Babcock Aircraft, (see Del-Air)

Ballard Aircraft Co., Inc., New York, N. Y.

Bowlus Sailplanes, Inc., Los Angeles, 14, Cal.

Briegleb Sailplane, (see Sailplane Corp.)

Bristol Aeronautical Co., New Haven, Conn.

California Aero Glider Co., Inc., Los Angeles, Cal

Cook Engrg. Co., Los Angeles, 11, Cal.

Del-Air Corp., Deland, Fla.

Dunbar Kapple, Inc., Chicago, 24, Ill.

Firestone Aircraft Co., Akron, Ohio

Fletcher Aviation Corp., Pasadena, 1, Cal.

Ford Motor Co., (see Aircraft)

Frankfort Sailplane Co., Joliet, Ill.

G & A Aircraft, Inc., Willow Grove, Pa.

General Aircraft Corp., Long Island City, 5, N. Y.

Gibson Elec. Refrigerator Corp., Greenville, Mich.

Gould Aeronautical Div., Deep River, Conn.

Hoosier Aircraft, (see Balard Aircraft)

Kilgen Aircraft Div., St. Louis, 13, Mo.

Kirsch Co., Sturgis, Mich.

Klassen Co., The, Los Angeles, Cal.

Laister-Kauffmann Aircraft Corp., St. Louis, 10, Mo.

McFarland Aircraft Co., Greenville, O.

National Aircraft Corp., Elwood, Ind.

National Bent Steel Corp., Brooklyn, N. Y.

Northwestern Aeronautical Corp., Minneapolis, Minn.

Pittsburgh Plate Glass Co., Pittsburgh, Pa.

Pratt, Read & Co., (see Gould Aeronautical)

Radioplane Co., Van Nuys, Cal.

Ridgefield Mfg. Corp., Ridgefield, N. J.

Robertson Aircraft Co., (see Aircraft)

St. Louis Aircraft Corp., (see Aircraft)

Sailplane Corp. of America, Santa Monica, Cal.

Schweizer Aircraft Corp., Elmira, N. Y.

Snead & Co., Jersey City, N. J.

Story & Clark Piano Co., Chicago, Ill.

Timm Aircraft Corp., (see Aircraft)

Waco Aircraft Co., The, (see Aircraft)

Warren Engrg. Co., Inc., New Haven, Conn.

White Aircraft Corp., Palmer, Mass.

Wiggins Airways, Inc., E. W., Norwood, Mass.

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- ☐ Private Pilot
- ☐ Weather Forecasting
- ☐ Women's Instrument Technician

Classified Directory of
Aviation Products and Services
WITH LIST OF SUPPLIERS

How to Use This Directory

THIS DIRECTORY of aviation suppliers is in two parts: The first, beginning on this page, is a listing of companies in alphabetical order under specific headings of products made or services supplied. The second, beginning on page 377, is a straight alphabetical listing of companies with addresses and personnel. Key numbers are provided to permit simple cross reference between the two parts of the directory.

Because of the vast varieties of aviation products, it is not feasible to make a separate, minute classification of each. If the product sought is not found under one of the following classifications, the reader is asked to refer to the classification most likely to include such a product.

Space limitations make it impossible to give a complete list of key personnel, but a sufficient list is included to serve most purposes of correspondence or negotiation.

1—ABRASIVES

Abeles Lewit Co., Inc.
Abrasive Co.
Aeronautical Trading Co.
Aircraft Steel & Supply Co., The
Almquist Bros. & Viets
Altens Fdry & Mach. Works
American Fdry Equipment Co.
American Gauge Co., The
Andrews Hardware & Metal Co.
Atkins & Co., E. C.

Bakelite Corp.
Bay State Prods Co.
Behr-Manning Corp.
Bettis Rubber Co.
Bridgeport Safety Emery Wheel
Busser Supply Co.

Carbide & Carbon Chem. Corp.
Carborundum Co., The
Carson, Marshall & Co., Inc.
Chamberlain Co.
Clover Mfg. Co.
Cordo Chemical Corp.

Divine Bros. Co.
Duer & Sons, Inc., John
Du Pont de Nemours & Co., Inc., E. I. Wilmington

Felker Mfg. Co.
Fuller & Co., W. P.

Gallien, R. P.
Gardner Mach. Co.
General Abrasive Co., Inc.

Hammel, Riglander & Co., Inc.
Hanson-Van Winkle-Munning Co.
Henkle & Joyce Hdwe. Co.
Hockaday & Phillips, Inc.
Hollingshead Corp., R. M.
Howell, Sherburne & Co.

Industrial Abrasives, Inc.
Industrial Engrg. Co., Inc.
Industrial Supply Co., Inc.

Kocour Co.

Lasalco, Inc.
L'Hommedieu & Sons Co.
Los Angeles Heavy Hardware Co.
Lowry Electrical Co., Inc.

McAleer Mfg. Co.
Mead Gliders & Specialties Co.
Mefford Chem. Co.
Metal Good Corp.
Mid West Abrasive Co.
Miller Co., J. C.
Milwaukee Elec. Tool Corp.
Minn. Mining & Mfg. Co.

Neal & Brinker Co.
Neal Co., Inc., R. C.
Norton Company

Pacific Abrasive Supply Co.
Pennsylvania Fdry. Sup. & Sand.
Precision Grinding Wheel Co.
Production Machine Co.

Reuther Equip. & Paint Co.
Reynolds-Robson Supply Co., The
Rheen Mfg. Co.
Rhodes & Co., James H.
Roberts Rubber Co., Weldon
Robertson Mfg. Co.

Speedometer Service & Access.
Stevens Inc., Fred B.
Summit Ind. Prod. Co.
Sunnen Prod. Co.

Timesaver Prod. Co.
Tull Metal & Supply Co., J. M.

U. S. Rubber Co.
U. S. Steel Supply Co.

Wagner Bros.
Wagner Co., Inc., Chas. A.
Walls Sales Corp.
Wedron Silica Co.
Welded Aircraft Parts Co.

2—ADHESIVES & GLUES

Abeles-Lewit Co., Inc.
Adhere, Inc.
Aeronautical Trading Co.
Airtack Adhesives
American Cellulose Co.
American Cyanamid Co.
Andrews Hardware & Metal Co.
Avondale Chemical Co.
Armstrong Cork Co.

B. B. Chemical Co.
Bakelite Corp.
Borg Warner Corp.
Brown & Bros., Arthur

Casein Co. of America
Catalin Corp.
Central Process Corp.
Chamberlain Co.
Continental Rubber Wks.

Delany & Co.
Divine Brothers Co.
Duer & Sons, Inc., John
Du Pont de Nemours & Co., Inc., E. I. (Plastics Dept.)
Du Pont de Nemours & Co., Inc., E. I. (Wilmington)
Durez Plastics & Chemicals, Inc.

Evans Products Co.

Ferdinand & Co., Inc.
Firestone Aircraft Co.
Fuller & Co., W. P. (San Francisco)
Fuller & Co., W. P. (Los Angeles))

Goodrich Co., The B. F.
Goodyear Aircraft Corp.
Goodyear Tire & Rubber Co., Inc.
Grumbacher, Inc.

Horn Co., A. C.

Kindt-Collins Co.
Knoedler Co.

Lasalco, Inc.
Laucks, Inc., I. F.
Lauxite Corp.
L'Hommedieu & Sons Co.
LePage's, Inc.
Little Bear Specialties Co., Inc.

Mefford Chemical Co.
Miller Co., J. C.
Minn. Mining & Mfg. Co.
Monite Waterproof Glue Co.
Mono Service Co.
Monsanto Chem. Co.,

Neal & Brinker Co.
Nobell Resins Co.

Perkins Glue Co.
Pierce & Stevens, Inc.
Plaskon Co., The
Plastics Div. Amer. Cyanamid
Resinous Prods. & Chem. Co.
Reuther Equip. & Paint Co.
Richter Engrg. Co.

Scholl Mfg. Co., Inc., The
Speedometer Service & Access. Co.
Speidel Co., Chas. W.
Standard Varnish Works
Stone Rubber Co.
Summit Ind. Prod. Co.
Synvar Corp.

U. S. Industrial Chemicals, Inc.
U. S. Rubber Co.
Universal Moulded Prod. Corp.

Van Cleef Bros.

Zephar Mills, Inc.

3—AIRFRAME PARTS & SUBASSEMBLIES

A & F Aluminum Prods Co.
A & S Tool Works Inc.
Ace Manufacturing Corp.
Adel Precision Products Corp.
Aerco Corp.
Aerial Machine & Tool Corp.
Aero Components Mfg. Co.
Aero Die & Stamping Co.
Aero Industries Tech. Inst.
Aero Parts Mfg. Co., Inc.
Aero Services Inc.
Aero Trades Co.
Aeroquip Corp.
Agawam Aircraft Products, Inc.
Air Cruisers, Inc.
Air Transport Equip. Inc.
Air Transport Mfg. Co.
Aircraft Associates Inc.
Aircraft Components, Inc.
Aircraft Containers Co.
Aircraft Development Co.
Aircraft Fitting Co.
Aircraft Hardware Mfg. Co.
Aircraft Instrument Service, Inc.
Aircraft & Marine Specialty
Aircraft Mechanics, Inc.
Aircraft Metal Forming Co.
Aircraft Prods. Co.
Aircraft Products, Inc.
Aircraft Products & Supply Co.
Aircraft Steel & Supply Co.
Aircraft Tool Co.
Aircraft Welded Clamp Co.
Aircraft Welders, Inc.
Aircraftsmen Co., The
Airex Mfg. Co.
Airframe Co.
Airply Forming Company
Alexander Tool & Mfg. Co.
All American Aircraft Prods.
Allied Aircraft Co.
Allied Aviation Corp.
Altens Fdry & Mach. Wks.
Aluminum Co. of America
American Aero Supply Co.
American Aluminum Ware Co.
American Aviation Corp.
American Brake Shoe Co.
American Central Mfg. Corp.
American Fitting Co.
American Smelting & Refining Co.
Anderson Mfg. Co.
Andrews & Perillo Mfg. Corp.
Anheuser Busch, Inc.
Apex Tool Co., Inc., The
Applegate Amphibians
Arnolt Motor Co.
Atlantic Diesel Corp.
Auld Co., The, D. L.
Aurora Equipment Co.
Aviation Engineering, Inc.
Aviation Parts, Inc.
Avion, Inc.

B & F Aircraft Engrg. Co.
B. H. Aircraft Co., Inc.
B & L Machine Tool & Die
Baker Furniture, Inc.
Bakewell Mfg. Co.
Ballard Aircraft Co., Inc.
Barcus Engineering Co.
Bellanca Aircraft Corp.
Bendix Products Div.
Benson Mfg. Co.
Berkey & Gay Furniture Co.
Beverly Grinding Service
Boardman Precision Mfg. Co.
Booth Mfg. Co.
Boyd & Co., Chas. P.
Bozung, J. A.
Brasco Mfg. Co.
Briggs Mfg. Co.
Brill Co., The, J. G.
Bristol Aeronautical Corp.
Brown Fence & Wire Company
Brown Industries
Bruening-Winans Corp.
Budd Mfg. Co., Edward G.
Burt Mfg. Co., The

Caine Steel Co.
Canfield Co., The H. O.
Carpenter Co., E. W.
Chamberlin Metal Weatherstrip
Char-Gale Mfg. Co.
Charles Mfg. Co.
Chautauqua Swaging Co.
Chicago Hardware Foundry
Cincinnati Ball Crank Co., The
Clifford Mfg. Co.
Cole Steel Equipment Co., Inc.
Colgate Aircraft Corp.
Columbia Aircraft Corp.
Columbia Aircraft Industries
Columbia Aircraft Products, Inc.
Columbia Stamping & Mfg. Corp.
Columbian Rope Co.
Continental Can Co.
Continental Rubber Wks.
Cook Engrg. Co.
Cosco Mfg. Co.
Cozine & Galley Mach. Co.
Crouse-Hinds Co.
Culver Aircraft Corp.

Dade Bros., Inc.
Deagen Inc., J. C.
Del-Air Corp.
Delvan Engineering Co.
Detroit Power Screwdriver Co.
Detroit Sheet Metal Works
Dickens, Inc.
Die Cast Corp.
Dix Machine Works
Dix Mfg. Co.
Doak Aircraft Co., Inc.
Doehler Metal Furniture Co., Inc.
Dolan Aircraft Mfg. Co.
Dunbar Kapple, Inc.
Duplicate Parts Co.
Dycer Aviation Supplies
Dyeo Engrg. & Sales
Edo Aircraft Corp.
Engel Aircraft Specialties
Engineering Develop. Assoc.
Engineering & Research Corp.
Epison Aircraft Corp.
Erie Art Metal Co., Inc.
Essick Mfg. Co.
Ex-Cell-O Corp.
Fabricated Products Co.
Expert Die & Stamp Co., The

Fahlin Mfg. Co.
Falstrom Co.
Federal Steel Corp.
Fenn Aircraft
Ferracute Mach. Co.
Firestone Aircraft Co.
Fleetwings Div.
Fletcher Aviation Corp.
Floorola Prods., Inc.
Flour City Ornamental Iron
Fixible Co., The
Formica Insulation Co.
Forrest Mfg. Co.

G & H Tool & Mfg. Co.
Gardner Co., J. R.
General Aircraft Corp.
General Bronze Corp.
Gilfillan Bros., Inc.
Glidden Buick Corp.
Globe Aircraft Corp.
Goodyear Aircraft Corp.
Graham-Paige Motors Corp.
Grammes & Sons, Inc., L. F.
Grand Rapids Industries, Inc.
Grossman Steel Stair Corp.

H & H Parts Co.
Hackensack Cable Corp.
Hall Lamp Co., C. M.
Hammond Aircraft Co.
Hardware Specialties Mfg. Co.
Harrisburg Steel Co.
Hartwell Mfg. Co.
Harvard Lock Co.
Harvey Machine Co., Inc.
Hauserman Co., Aircraft Div.
Hayes Industries, Inc.
Hayes Mfg. Corp.
Heath Co.
Herman Mach. & Tool Co., The
Highland Stamping & Mfg. Co.
Hi Standard Mfg. Corp.
Higgins Aircraft, Inc.
Hill Aircraft Streamliners Co.
Hockaday Aircraft Corp.
Hoe & Co., R.
Hoosier Lamp & Stamping Corp.
Houston Corp.
Hudson Motor Car Co.
Hughes Aircraft Co. (Cargo Div.)
Hunter Sash Co., Inc.
Husband Aircraft Specialties, Inc.

Indiana Veneer & Panel Co.
Interstate Aircraft & Engrg.

Jamestown Steel Partitions, Inc.
Jensen Mach. Co., Inc.
Johnson-Carper Furniture Co.

Kay Prods Co.
Kelley-Koett Mfg. Co., The
Keith Mfg. Co.
Keystone Aircraft Prods., Inc.
Kilgen Aircraft Div.
King Plastics Corp.
Kinmont Mfg. Co.
Kinney Engrg. Co.
Kirsch Co.
Kite Aircraft Corp.
Knape & Vogt Mfg. Co.
Koch Refrigerator
Krehbiel Plastic Products
Kroehler-Doak Aircraft Parts

L. A. Automotive Works
Lake State Prods., Inc.
Langley Corp.
Lavelle Aircraft Corp.
Lester Industries, Inc.
Liberty Aircraft Products Corp.
Lights, Inc.
Lloyd Mfg. Co.
Lombard Mach. Co.
Lone Star Aircraft Co.
Lonergan Mfg. Co.
Longren Aircraft Co.
Lorensen Industries
Luscombe Airplane Corp.

McAleer Mfg. Co.
McDonnell Aircraft Corp.
McInerney Plastics Co.
McKee Door Co.
Mahl Mfg. Co.
Manlove & Spaulding
Marlin Firearms Co.
Martin-Decker Corp.
Martin-Parry Corp.
Martin & Schwartz, Inc.
Master Aircraft Parts Co.
Masters, Inc., Irvin W.
Mayer Mfg. Corp.
Maysteel Prods., Inc.
Mercury Aircraft, Inc.
Metal Products Engrg., Inc.
Meteor Motor Co., The
Meyers Aircraft Co.
Miller Co., The, A. J.
Miller-Robinson Co.
Miro-Flex Co.
Monarch Metal Weatherstripp. Co.
Monarch Tool & Instrument Co.
Moore Eastwood & Co.
Morrow Aircraft Co.
Morton Mfg. Co.
Motor Products Corp.
Motors Metal Mfg. Co.
Moynahan Bronze Co.
Mullenbach Electrical Mfg. Co.
Murray Corp. of America

National Aircraft Equip. Co.
National Bent Steel Corp.
National Bronze & Aluminum
National Machine Products
National Postal Meter Co.
National Pneumatic Co.
National Radiator Co., The
Neu-Bart Stamping & Mfg. Co.
Newark Stove Co.
Nichols & Cox Lumber Co.
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Parachute Corp. of America, Inc.
Parker Appliance Co.
Paul & Beekman Div.
Peninsular Metal Prods. Corp.
Penn Elastic Co.
Pennsylvania Furnace & Iron Co.
Phillips Aviation Co.
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Pittsburgh Plate Glass Co.
Plastic Mfgs., Inc.
Plastic Prod. Co.
Pluswood, Inc.
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Plymold Corp.
Potters, Inc., L.
Pressed Steel Tank Co.

REF Aircraft Corp.
Reisner & Co., Inc.
Reliable Spring & Wire Forms Co.
Reliance Machine & Mfg. Co.
Reynolds Metals Co.
Rheem Mfg. Co.
Ridgefield Mfg. Corp.
Riehle Mach. Co.
Roberts & Mander Stove Co.
Robertson Aircraft Corp.
Rocky Mountain Steel Prods., Inc.
Rohr Aircraft Corp.
Rowe Industries

St. Louis Aircraft Corp.
Samson United Corp.
Shank Metal Products Co.
Sierra Mfg. Co.
Simmons Mfg. Co.
Skylark Mfg. Co., Inc.
Soreng-Manegold Co.
So-Cal Foundry
Southern Aircraft Corp.
Southern Calif. Airparts Div.
Southern Calif. Plating Co.
Spartan Aircraft Co.
Special Mach. Tool Engrg. Wks.
Spier Aircraft Corp.
Spriesch Tool & Mfg. Co., Inc.
Stainless Steel Aircraft Corp.
Standard Insulation Co.
Star Machine & Tool Co.
Stegner & Sons, Chas. V.
Steel Forming Corp.
Sterling Aluminum Prod., Inc.
Stout Research Div.
Strickland Aircraft Corp., The
Super-Cold Corp., The
Swallow Airplane Co., Inc.
Swan Eng. Co., Inc.
Swedlow Aeroplastics Corp.
Swift Lubricator Co.
Symmetric Mfg. Co.

Tammany Mach. Shop
Tappan Stove Co., The
Taylorcraft Aviation Corp.

I NEEDED A RELAY

as short as this . . . and long on stamina

"AND I found it in the Automatic Electric Class "S." This tiny relay is marvelously compact, light in weight and packs plenty of power. But that's only part of the story. For dependability under tough service conditions, I haven't found its equal."

• • •

The Class "S" Relay was designed especially for dependable use on fast modern aircraft, where vibration and acceleration are tough obstacles for *any* electrical equipment. Here are some of the reasons why Class "S" does its job so well:

1. Vibration resistance is part of its basic design—built-in, not added on. It surpasses the most rigorous tests required by the Signal Corps and the Air Forces.
2. Its unique spring design provides high contact pressure within small space limits.
3. Twin contacts — independent, self-cleaning — provide maximum contact dependability.
4. Pin-pivoted armature with full length bearing provides long working life under tough service conditions.

To get the full story on Class "S" and other Automatic Electric relays, write for Catalog 4071—the most comprehensive handbook ever published on relays and their application.

Class "S" Relays are available with a wide variety of coil and contact combinations, and operate and release speeds. The single arm relay shown above has a capacity of six contact springs—the double arm, twelve springs.

Relays
AND OTHER CONTROL DEVICES
by **AUTOMATIC ELECTRIC**

Distributed by

AUTOMATIC ELECTRIC SALES CORPORATION
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PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED

...icher Mfg. Corp.
...nessee Aircraft, Inc.
...x Machine Co.
...alite, Inc.
...aden Engineering Co.
...mm Aircraft Corp.
...rbon Engineering Corp.
...rader-Aero Supply, Bob
...ranscontinental Mach. & Tool
...ropic-Air... Inc.
...ler Fixture Corp.
...son Bearing Co.
...ited-Carr Fastener Corp.
...S. Propellers, Inc.
...iversal Moulded Products Corp.
...ility Fan Corp.
...an Camp Mfg. Co.
...ard, Inc.
...ariety Aircraft Corp, The
...idal Research Corp.
...iking Air Cond. Corp.
...irginia Rubatex Div.

...agner C... Paul G.
...allace Bros., Inc.
...allace Supplies Mfg. Co.
...ard Heater Co.
...arren Engrg. Co., Inc.
...ashington Iron Works
...aukesha Motor Co.
...eber Showcase & Fixture Co.
...elded Aircraft Parts Co.
...ells Aircraft Parts Co.
...est Branch Novelty Co.
...estcraft, Inc.
...estern Arc Welding, Inc.
...estern Mfg. Supply Co.
...estinghouse Elect. & Mfg. Co. (Pittsburgh)
...estinghouse Electric & Mfg. Co. (Lima)
...etzler Clamp Co., The
...harry & Co., Inc., G. A.
...hite Aircraft Corp.
...icks Organ Co.
...iggins Airways, Inc., E. W.
...orcester Pressed Steel Co.

...agar Tool, Inc.
...amax Mfg. Co.
...ill Corp.
...ebarth Co., Frits
...erold Metals Co.

...-AIRPORT EQUIPMENT

...dams Grease Gun Corp.
...erolites Corp.
...eronautical Trading Co.
...irchox Div.
...ircraft Products, Inc.
...irdesign and Fabrication, Inc.
...irplane Mfg. & Supply Corp.
...lis-Chalmers
...llith-Prouty, Inc.
...merican Airport Equipment Co.
...merican Art Metals Co.
...merican Bitumuls Co.
...merican Foundry & Furnace Co.
...merican Gauge Co., The
...merican Heating & Ventilating
...merican Radiator Co.
...merican Radio Mfg. Co., Inc.
...merican Roof Truss Co.
...pex Steel Corp., Ltd.
...qua Systems, Inc.
...rch Roof Construction Co.
...rmstrong Cork Co.
...they Truss Wheel Co.
...tlas Car & Mfg. Co., The
...urora Equipment Co.
...utomatic Electrical Devices Co.
...viation Engineering, Inc.
...viometer Corp.
...viquipo, Inc.
...aker Mfg. Co., The
...akewell Mfg. Co.
...erger Mfg. Div.
...law-Knox Co.
...onded Scale Co.
...owser, Inc.
...utler Mfg. Co.
...yrne Doors, Inc.

...H. & E. Mfg. Co.
...arey Mfg. Co., The, Philip
...aterpillar Tractor Co.
...harles Mfg. Co.
...hicago Hardware Foundry Co.
...layborne Mfg. Co.
...olumbian Steel Tank Co.
...olvinex Corp.
...ontractors Machy Co., Inc.
...rnell Iron Wks., Inc.
...ouse Laboratories, Inc.
...ouse-Hinds Co.
...urtis Lighting, Inc.
...urtiss & Smith Mfg. Corp.
...avis Emergency Equip. Co., Inc.
...el-Air Corp.
...eming Co., The
...emison Engineering Co.
...oolittle Radio, Inc.
...over Compressor Co.
...aton Metal Products Co.
...dwards Iron Works, Inc.
...lectric Speed Indicator Co.
...lectric Sprayit Co., The
...lectrolux Corp.
...lectronic Laboratories, Inc.
...lkhart Brass Mfg. Co., Inc.
...ple Meter Systems, Inc. (Pa.)
...merick Mfg. Co.
...vans Appliance Co.
...airbanks, Morse & Co.
...alstrom Co.
...ederal Aircraft Wks.
...ederal Elec. Co., Inc.
...ederal Telephone & Radio Corp.
...irestone Aircraft Co.
...letcher Aviation Corp.
...lorsheimer Bert, B.
...our Wheel Drive Auto Co.
...rank Mfg., Carl H.
...uller, R. P.
...arlinghouse Bros.

...HF Mfgs.
...agedorn Engineering
...artman Equipment Co.
...awkins Structural Steel Co.
Heil Co., The
Hettrick Mfg. Co., The
Howe Scale Co., The

Ideal Power Lawn Mower Co.
Independent Pneumatic Tool Co.
Indian Motorcycle Co.
Industrial Controller Div.
Ingalls Iron Works Co.
International Derrick & Equip.
International Steel Co.

Jacobson & Co., Inc.
Jefferson-Travis Radio Mfg. Corp.
Jamestown Steel Partitions, Inc.

Kato Engrg. Co.
Kellogg Div. of Amer. Brake Shoe
Kenyon Instrument Co.
Keystone Aircraft Products, Inc.
Kidde & Co., Walter
Kinnear Mfg. Co.
Klauer Mfg. Co.
Kron Co., The

Logan Co.
Liberty Motors & Engrg. Corp.
Lights, Inc.
Lincoln Engr. Co.
Lister-Blackstone, Inc.
Louden Machy. Co.
Lowry Electrical Co., Inc.
Lumidor Mfg. Co.

Malabar Machine Co.
McKee Door Co.
Mansion House Furniture Co.
Marmon-Harrington Co., Inc.
Martin & Schwartz, Inc.
Mawaco Machine Co.
Merrill Engrg. Laboratories
Metal Fabricators, Inc.
Morton Mfg. Co.

Neal & Brinker Co.
Neptune Meter Co.
Neu-Bart Stamping & Mfg. Co.

Ohio Elec. Mfg. Co.
Ohio Pattern Wks. & Foundry
Ornitz & Co., Edward M.

Pacific Engrg. Corp.
Pacific Fabricating Co.
Patent Scaffolding Co., Inc., The
Penn Metal Corp. of Penna.
Pennsylvania Furnace & Iron Co.
Perey Turnstile Co.
Phila. Valve Co.
Phillips Pump & Tank Co.
Plymold Corp.

Q. R. S. Neon Corp., Ltd.

Radio Receptor Co., Inc.
Rauland Corp., The
Reilly Tar & Chemical Corp.
Reuther Equip. & Paint Co.
Richards-Wilcox Mfg. Co.
Rilco Laminated Products, Inc.
Robertson Co., H. H.
Rocky Mountain Steel Prods., Inc.
Roof Structures, Inc.
Roseman Tractor Mower Co.

Safway Steel Products, Inc.
Searle Aero Industries, Inc.
Sedgwick Machine Wks.
Shields, Harper & Co.
Snow Removal Equip. Co.
Southern Engineering Company
Sparkes Mfg. Co.
Sparks-Withington Co., The
Square D Co.
Standard Machy. Co.
Stewart, M. C.
Stow Mfg. Co., Inc.
Streeter-Amet Co.
Sturtevant Co., B. F.
Super-Cold Corp., The
Switch & Panel Div.

Taft Peirce Mfg. Co.
Taylor Machine Co., The
Tex Machine Co.
Timber Engr. Co.
Toledo Standard Commutator Co.
Transmitter Equip. Mfg. Co., Inc.
Trowbridge Conveyor Co.
Truscon Steel Co.
Turtle & Hughes, Inc.
Tyler Fixture Corp.

U. S. Air Compressor Co.
Universal Bldg. Prods. Corp.
Universal Engrg. Corp.

Voight & Sons Co., R.
Vulcan Electric Co., Div.

Walker Mfg. Co. of Wis.
Walter Motor Truck Co.
Wellington Machine Co., The
Westinghouse Elect. & Mfg. Co.
White Motor Co.
Whiting Corp.
Willamette Hyster Co.
Wing Mfg. Co., L. J.
Wolfe & Mann Mfg. Co.
Worthington Mower Co.
Worthington Pump & Machy Corp.

Yates-American Machine Co.

4a—ANODIZING (see 68)

5—ARMAMENT & EQUIPMENT

Aerial Mach. & Tool Corp.
Aero Supply Mfg. Co., Inc.
Advance Aircraft Tool Co.
Air Associates, Inc.
Aircraft Accessories Corp. (Burbank, Cal.)
Aircraft Components, Inc.
Althens Fdry & Mach'y Works
Aluminum Gds. Mfg. Co.
American Armament Corp.
Atkins & Co., E. C.
Atlantic Diesel Corp.
Atlas Tool & Designing Co.
Ault & Wiborg Corp.

Baldwin-Duckworth Div.
Bell & Howell Co.
Bendix Products Div.
Borg Warner Corp.
Breeze Corps., Inc.
Brussell Sewing Machine Co., Inc.
Budd Mfg. Co., Edward G.
Burklyn Co.
Chicago Hardware Foundry Co.
Cole Steel Equipment Co., Inc.
Columbia Aircraft Products, Inc.
Columbia Machy & Engineering
Corry-Jamestown Mfr. Corp.
Cunningham Hall Aircraft Corp.

Dayton Tool Engr. Co.
Diebold Safe & Lock Co.

Electrolux Corp.
Electronic Laboratories, Inc.
Engineering Appliance Co.
Engineering Development Assoc.
Engineering & Research Corp.
Epison Aircraft Corp.
Erie Art Metal Co., Inc.

Fairchild Aviation Corp.
Falstrom Co.
Ferracute Mach. Co.

Gassner Co., Inc., Thomas S.
General Aircraft Equip. Inc.
General Electric Co.
Guardian Electric Co.

H-M Thermo Control Co.
Hardman Aircraft Prods., Inc.
Harvey Machine Co.
Herron-Zimmers Moulding Co.
Hi Standard Mfg. Corp.
Hoe & Co., R.
Hughes Aircraft Co., Arma. Div.
Husband Aircraft Specialties, Inc.

Interstate Aircraft & Engrg. Corp.

Jamestown Steel Partitions, Inc.
Jowein, Inc., Metal Prods.

Keeney & Co., Inc., J. H.
Kelley-Koett Mfg. Co., The
Kenyon Instrument Co.
Kinmont Mfg. Co.

Lights, Inc.
Lukenweld, Inc.
Luscombe Airplane Corp.

MacGlashan Air Machine Gun Co.
Martin-Parry Corp.
Maxson Corp., The, W. L.
McQuay, Inc.
Moore-Eastwood Co.
Moss & Co., Henry

National Machine Products
National Pneumatic Co.
Neu-Bart Stamping & Mfg. Co.
Norden Co., Carl

Pacific Fabricating Co.
Paramount Textile Machy Co.
Paul & Beekman Div.
Persons Corp., L. M.
Peterson, F. Somers, Co.
Plastic Mfgs., Inc.
Polaroid Corp.
Pollak Mfg. Co.
Porter Mach. Co.
Precision Prods., Inc.

Saginaw Prods. Corp.
Simmonds Saw & Steel Co.
Saxl Instrument Co.
Samson United Corp.
Service Tool & Engr. Co.
Shank Metal Prods. Co.
Southern Aircraft Corp.
Sparkes Mfg. Co.
Sparks-Withington Co., The
Spencer Heater Div.
Sperry-Gyroscope Co.
Spriesch Tool & Mfg. Co., Inc.
Standard Products Co., The
Star Mach. & Tool Co.
Sterling Aluminum Prod., Inc.
Super Cold Corp., The

Televiso Products, Inc.
Tex Machine Co.
Tietzmann Engrg. Co.
Triumph Explosives, Inc.
Twin City Tool Co.

U. S. Propellers, Inc.
U. S. Spring & Bumper Co.
Universal Bldg. Prods. Corp.
Universal Cooler Corp.

Van Dorn Iron Wks. Co., The

Western Cartridge Co.
Westinghouse Elec. & Mfg. Co. (Pittsburgh)

York Safe & Lock Co.
Young Spring & Wire Corp., L. A.

6—AUXILIARY POWER PLANTS

Airplane Mfg. & Supply Corp.
American Aircraft Mfg. Co.
Andover Motors Corp.
Arnolt Motor Co.

Bogue Electric Co.
Borg Warner Corp.

Continental Motors Corp.

Delco Appliance Div.

Eclipse Pioneer Div.
Electric Spravit Co., The
Electronic Laboratories, Inc.

General Electric Co.

Homelite Corp.

Indian Motorcycle Co.

Kohler Co.

Lawrance Aeronautical Corp.
Lister-Blackstone, Inc.

McCullough Aircraft Co.
Menaugh-Dutterer Co.

Onan & Sons, D. W.

Pioneer Gen-E-Motor

Rheem Mfg. Co.
Rohr Aircraft Corp.
Ross Heater & Mfg. Co., Inc.

Samson United Corp.
Smith Mfg. Co., Nathan R.
Tabor Mfg. Co.
U. S. Motors Corp.
United Welding & Mfg. Co.
Universal Motor Co.
Westinghouse Electric & Mfg. Co. (Lima Works)
White Engineering Co.

7—BATTERIES

Aircraft Instrument Service, Inc.
Altens Fdry & Mach'y Works
Auto Lite Battery Corp. of Cal.
Automatic Electrical Devices Co.
Burgess Battery Co. (Freeport)

Delco Remy Div.
Dillin Organization, Frank W.

Electric Auto Lite Co.
Electric Storage Battery Co.
Firestone Aircraft Co.

Garfield Electrical Supply Co.
General Lead Batteries Co.
Gould Commercial Div.
Gould Storage Battery Co.
Graybar Electric Co., Inc.

Henkle & Joyce Hdwe. Co.
Hockaday & Phillips, Inc.
Hood Rubber Co.

Lights, Inc.

Mueller Electric Co.

Philco Corp.
Prest-O-Lite Battery Co., Inc.
Price Battery Corp.

Ray-O-Vac Co.
Reading Batteries, Inc.
Reuther Equip. & Paint Co.
Reynolds Molded Plastics

Speedometer Service & Accessories
Standard Electric Co., Inc.
Standard Elec. Time Co., The

Trader-Aero Supply, Bob
Triumph Explosives, Inc.
Turtle & Hughes, Inc.

U.S.L. Battery Corp. of Calif.
U. S. Rubber Co.

Wharry & Co., Inc., G. A.
Willard Storage Battery Co.

8—BEARINGS

Abeles-Lewit Co., Inc.
Abbott Ball Company, The
AC Spark Plug Div.
Acorn Bearing Co.
Aeronautical Trading Co.
Aetna Ball Bearing Mfg. Co.
Ahlberg Bearing Co.
Aircraft & Marine Specialty Co.
Air-Parts, Inc.
Allison Div., General Motors Corp.
Almquist Bros. & Viets
American Crucible Products Co.
American Gauge Co., The
American Manganese Bronze Co.
Ampco Metal Inc.
Amplex Div. of Chrysler Corp.
Andrews Hardware & Metal Co.
Atlas Brass Foundry

Bantam Bearings Corp.
Ball & Roller Bearing Co., The
Barcus Engr. Co.
Bearium Metals Corp.
Beemer Engr. Co.
Bickford & Francis Belting Co.
Bohn Aluminum & Brass Corp.
Bound Brook Oil-Less Bearing
Bower Roller Bearing Co.
Buckeye Brass & Mfg. Co. (Bronze Sleeve)
Bunting Brass & Bronze Co.

Cal-Air Prod. Co.
Casco Prods. Corp.
Chicago Hardware Foundry Co.
Chrysler Corp., Amplex Div.
Cleveland Graphite Bronze Co.

Detroit Aluminum & Brass Corp.
Dix Machine Works

Fafnir Bearing Co., The
Federal Bearings Co., Inc., The
Federal-Mogul Corp.

G. & G. Precision Wks.
Gatke Corp.
General Elec. Co. (Plastics Div.)
General Lead Batteries Co.
Gwilliam Co., The

Hall Lamp Co., C. M.
Heim Co.
Henkle & Joyce Hdwe
Hockaday & Phillips, Inc.
Hyatt Bearings Div., Gen.

Industrial Supply Co., Inc.

Johnson Bronze Co.

Kendrick Mfg. Co.
Kingwell Bros., Ltd.
Kinmont Mfg. Co.
Kirsch Co.

Lawrence Co., Neil F.
Link-Belt Co.

McGill Mfg. Co., Inc.
McInerney Plastics Co.
McQuay-Norris Mfg. Co.
Mallory & Co., Inc., P. R.
Marlin-Rockwell Corp.
Martin & Schwartz, Inc.
Master Aircraft Parts Co.
Miniature Precision Bearings
Moffatt Bearing Co.
Moraine Products Div.
Mueller Brass Co.

Olds Alloy Co.

National Lead Co.
New Departure Div.
Nice Ball Bearing Co.
Norma-Hoffman Bearings Corp.

Orange Roller Bearing Co., Inc.

Pacific Bearings Co.
Panelyte Div.
Phillips Bronze Corp.
Phosphor Bronze Smelting Co.
Plastic Prod. Co.
Precision Bearings, Inc.

R-S Products Corp.
Randall Graphite Products Corp.
Reliable Mach. Shop
Renewal Service
Roller Bearing Co. of America

S.K.F. Industries, Inc.
Saxl Instrument Co.
Schatz Mfg. Co., The
Se-Ling Aircraft Co.
Shelburne Co., A.
Shenango-Penn Mold Co.
Speedometer Service & Accessories
Split Ball Bearing Corp.
Standardized Aircraft
Stephens-Adamson Mfg. Co.
Summit Ind. Prod. Co.
Tex Machine Co.
Timken Roller Bearing Co., The
Torrington Co., The
True Alloys, Inc.
Tubular Alloy Steel Corp.
United Aircraft Products, Inc.
U. S. Graphite Co., The

8a—BOLTS, see 30

9—BOOKS, MAPS, CHARTS—AVIATION

Abrams Instrument Corp.
Aero Publishers
Aero Service Corp.
Aerosphere, Inc.
Aeronautical Trading Co.
Air-Parts, Inc.
Air-Transport Equip., Inc.
American Technical Society
Aviation Press
Columbia University Press
Drake & Co., Frederick J.
Elemoto Sales
Funk & Wagnalls Co.
Harper & Bros.
International Map Co., Inc.
Jordanoff Aviation Corp.
Likaglobe
McGraw-Hill Book Co.
MacMillan Co., The
MacRae's Blue Book
Military Service Publishing Co.
National Foremen's Institute
Paulson & Co., Henry J.
Pitman Publishing Corp.
Prentice-Hall, Inc.
Printloid, Inc.
Rand McNally & Co.
Range Data, Inc.
Ronald Press Co.
Roy, Ross, Inc.
Speidel Co., Chas. W.
U. S. Coast & Geodetic Survey
Weems System of Navigation
Wharry & Co., Inc., G. A.
Wiley & Sons, Inc., John

9a—BUSINESS MACHINES, EQUIPMENT, SYSTEMS

Addressograph-Multigraph Corp.
Dictaphone Corp.
Executone, Inc.
International Business Mach.
Remington Rand, Inc.
Screw Mach. Prods. Co.
Sound Scriber Corp., The
Standard Register Co., The
Tel Autograph Corp.
Teleregister Corp.
Wassell Organization

10—CABIN HARDWARE & FURNISHINGS

Aero Bolt & Screw Co.
Aircraft Specialties Co.
Airsealand Aircraft, Inc.
Alto Mfg. Co.
American Radio Hardware Co.
Armstrong Cork Co.
Art Metal Construction Co.
Aviation Engineering, Inc.
Aviation Parts, Inc.
Aurora Equipment Co.

Bassick Co., The
Bemis & Call Co.

Charles Mfg. Co.
Chicago Hardware Foundry Co.
Corbin Cabinet Lock Div.
Corbin P & F

Dayton Mfg. Co., The
Delavan Engineering Co.
Dolan Aircraft Mfg. Co.
Duer & Sons, Inc., John

Engel Aircraft Specialties
Epison Aircraft Corp.
Excelsior Hdwe. Co., The
Extruded Plastic, Inc.

Formica Insulation Co., The
Fulton Co., The

General Bronze Corp.
Goodyear Aircraft Corp.
Grossman Steel Stair Corp.

Hardware Specialty Mfg. Co., The
Harvard Lock Co.
Heath Co.
Highbridge-International Co.
Hubbard Machine Products, Inc.
Hunter Sash Co., Inc.

Johnson & Faulkner, Inc.

Keil & Son, Inc.

Liberty Mirror Works Div.
Lyon Metal Prods. Inc.

Marine Air Research Corp.
Martin-Parry Corp.
Mason Co., Thomas
Met L Wood Corp.
Moore-Eastwood Co.
Moss & Co., Henry

National Lock Co.
National Vulcanized Fibre Co.

Peterson, F. Somers, Co.
Pitkin Mach. Works
Post Electric Co.
Porter, Inc., L.

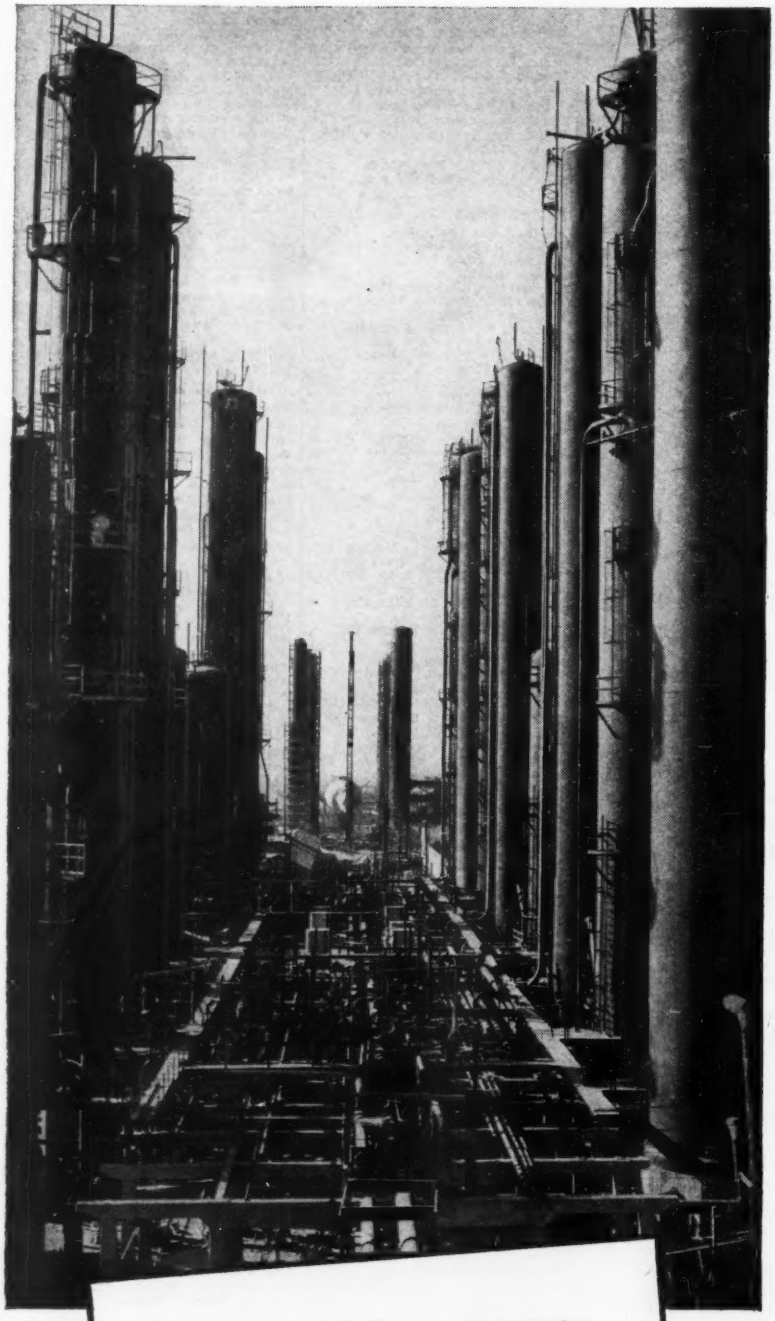
Reynolds Molded Plastics
Rite Hardware Mfg. Co.

Schiegel Mfg. Co., The
Snapvent Co.
Special Mach. Tool Engrg. Wks.
Soss Mfg. Co.
Stanley Wks., The
Stegner, Chas. V. & Sons
Stewart Warner Corp.
Switlik Para. Co.

Torrance Precision Mfg. Co.
Torrington Mfg. Co.
Townsend Co.
Trade-Wind Motorfans, Inc.

Wagner Mfg. Co., E. R.
Ward Heater Co.
Weber Showcase & Fixture Co.

COMBINED OPERATIONS... oilmen's style!



Combined Operations is a Commando term for a fierce, concentrated attack on an objective with every available weapon.

And it was with just such tactics that the petroleum industry waged a campaign for one of America's most critical war objectives . . . *Rubber!*

If America was to have rubber, we needed a lot of butadiene fast! So the Government and representatives of many oil companies held a conference. It was suggested that one big plant could produce more butadiene cheaper and faster than five small plants.

Everyone agreeing, the Neches Butane Products Company was organized by Atlantic, Gulf, Pure, Socony Vacuum, and Texaco. This nonprofit organization had access to the finest research facilities, the pooled technical knowledge, and the best brains in the petroleum industry—*at no cost to the Government!*

That's . . . *Combined Operations!*

Well, the problems the Combined Operators ran into were numerous . . . some of them seemed downright impossible.

But all of them were licked!

During the last 24 months, the Neches Butane Products Company has grown from an urgent idea into a plant that will produce enough butadiene to make 246 million pounds of synthetic rubber a year! In just 24 months, 314 bare Texas acres have been covered with a multi-million dollar installation of intricate equipment—equipment that will soon be helping to do the work of 45,000,000 rubber trees!

Combined Operations with a vengeance!

BUILT AND OPERATED through oil industry and Government co-operation . . . without profit . . . for the successful prosecution of the war . . . and a victorious peace.

GULF

Werner Co., Inc., R. D.
Westcraft, Inc.
Wharry & Co., Inc., G. A.
Whitehead Stamping Co.
Yale & Towne Mfg. Co., The

11—CABIN SUPERCHARGING EQUIPMENT

Aero Engineering, Inc.
AiResearch Mfg. Co.
Armstrong Cork Co.
Barber-Colman Co.
Borg Warner Corp.
Eclipse Pioneer Div.
Electric Sprayit Co., The
Fedders Mfg. Inc.
Garrett Corp., The
General Elec. Co.
Hagedorn Engineering
Lawrance Aeronautical Corp.
Lorenzen Industries
McCulloch Engineering Corp.
Persons Corp., L. M.
Pesco Prod. Co.
Reynolds Molded Plastics
Roots-Connersville Blower Corp.
York Shipley, Inc.
Westinghouse Elect. & Mfg. Co. (Lima)

12—CARBURETORS

Abeles-Lewit Co., Inc.
Aeronautical Products, Inc.
Aircraft Instrument Service, Inc.
Air-Maze Corp.
American Liquid Gas Corp.
Armstrong Cork Co.
Arnolt Motor Co.
Bendix Products Div.
Bethlehem Equip. Corp., Ltd.
Borg Warner Corp.
Bowling Green Rubber Co.
Chandler-Evans Corp.
Columbia Aircraft Products, Inc.
Detroit Lubricator Co.
Hockaday & Phillips, Inc.
Holley Carburetor Co.
Lobdell-Emery Mfg. Co., The
Marvel-Schebler Carburetor Div.
Production Tooling Co.
Robins Conveyors, Inc.
Speedometer Service & Accessories
Zenith Carburetor

12a—CARGO LOADING, AND TIE DOWN EQUIPMENT

Barrett-Cravens Co.
Evans Prods. Co.
Mechanical Handling Systems
Pacific Railway Equip. Co.
Pioneer Engrg. Wks., Inc.
Saginaw Prods. Corp.
Schulb Trailers, Inc.
Seitzman & Sons
Super-Cold Corp., The
Trowbridge Conveyor Co.

13—CASTINGS—METAL MOLD

A & F Aluminum Prods. Co.
Acme Pattern & Tool Co., Inc.
Advance Aluminum Castings Corp.
Aero Components Mfg. Co.
Aero Services, Inc.
Alemite Die Casting
Allegheny Ludlum Steel Corp.
Alpha Metal & Rolling Mills, Inc.
Altens Fdry & Mach. Works
Aluminum Alloys Corp.
Aluminum Casting & Engineering
Aluminum Co. of America
Aluminum Industries, Inc.
American Brass Co., The
American Art Alloys, Inc.
American Crucible Products Co.
American Magnesium Corp.
American Manganese Bronze Co.
American Smelting & Refining
American Steel Casting Co.
Ampco Metal, Inc.
Anderson Die Casting
Artistic Bronze Tablet Co., Inc.
Atlantic Casting & Engineering
Atlas Foundry Co.
Beemer Engr. Co.
Bendix Products Div.
Beryllium Corp. of Pa., The
Bohn Aluminum & Brass Corp.
Capital Fdry. Corp.
Central Pattern & Fdry Co.
Challenge Mach. Co., The
Chambersburg Engrg. Co.
Chase Brass & Copper Co., Inc.
Chicago Hardware Foundry Co.
Collord, Inc.
Compton Metals, Inc.
Cooper Alloy Fdry. Co.
Crescent Mach. Co.
Ray Day Piston Corp.
Detroit Magnesium & Aluminum Die Cast Corp.
Dockson Corp.
Doehler Die Casting Co.
Dollin Corp.
Dow Chemical Co.
Duriron Co., Inc., The
E F G Engineering Works, Inc.
Eastern Malleable Iron Co.
Ebaloy Foundries, Inc.
Eclipse Pioneer Div.
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Elkhart Brass Mfg. Co., Inc.
Engineering Appliance Co.
Eveready Hardware Mfg. Co.
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Gorham Mfg. Co., The
Hamilton Fdry & Mach. Co.
Jolley Co., J. H.
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Kinney Aluminum Co.
Kinney Engrg. Co.
Kirsten Pipe Co.
Lights, Inc.
Link-Belt Co.
McGill Mfg. Co., Inc.
Majestic Co., The
Metal Fabricators, Inc.
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Miller Co., The
National Bronze & Aluminum
New Products Corp.
Newton New Haven Co.
North Wales Mach. Co.
Northfield Foundry & Machine
Ohlsson & Rice Mfg. Co.
Pan American Alloys, Inc.
Parker White Metal & Mach Co.
Permold Co., The
Plastic & Die Cast Products
Porter Mach. Co.
Precision Castings Co., Inc.
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Ritter Co., Inc.
Rogers Pattern & Fdry. Co.
Ross-Meehan Fdries
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Spencer Heater Div.
Soss Mfg. Co.
Speedometer Service & Accessories
Sterling Aluminum Prod., Inc.
Tex Machine Co.
Toman & Co., Inc., E.
True Alloys, Inc.
Union Die Casting Co., Ltd.
U. S. Pipe & Mfg. Co.
Warman Steel Casting Co.
Western Die Casting Co.
Western Mfg. & Supply Co.
Zimmerman Steel Casting Co.

14—CASTINGS—SAND

Acme Aluminum Foundry Co.
Acme Pattern & Tool Co., Inc.
Acme Steel & Malleable Iron
Adams & Westlake Co.
Advance Aluminum Castings
Alemite Die Casting
Altens Fdry & Mach. Works
Aluminum Alloys Corp.
Aluminum Co. of America
Aluminum Industries, Inc.
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American Art Metals Co.
American Crucible Products Co.
American Foundry & Furnace Co.
American Manganese Steel Div.
American Steel Castings Co.
Ampco Metal, Inc.
Apex Steel Corp., Ltd.
Arnolt Motor Co.
Arrow Brass Foundry
Atlantic Casting & Engineering
Atlas Foundry Co.
Aviquipo, Inc.
Bearium Metals Corp.
Bedford Bronze Foundry, Inc.
Bendix Products Div.
Beryllium Corp. of Pa., The
Bohn Aluminum & Brass Corp.
Boose Aluminum Fdry.
Buckeye Iron & Brass Works
Capital Fdry. Corp.
Castalloy Co., Inc.
Central Pattern & Fdry Co.
Challenge Mach. Co., The
Chambersburg Engrg. Co.
Chicago Hardware Foundry Co.
Columbia Steel Co.
Commerce Pattern Fdry.
Covel Mfg. Co.
Ray Day Piston Corp.
Detroit Aluminum & Brass Corp.
Detroit Lubricator Co.
Detroit Magnesium & Aluminum
Dow Chemical Co.
Dunbar Kapple, Inc.
Duriron Co., Inc., The
E F G Engineering Works, Inc.
Eaton Mfg. Co.
Eaton Mfg. Co. (Cleveland)
Ebaloy Foundries, Inc.
Eclipse Aviation—Pioneer Instr.
Electric Steel Foundry Co.
Engineering Development Assoc.
Ertel Mach. Co.
Flour City Ornamental Iron Co.
Flynn & Emrich Co.
Food Machy. Corp.
Frontier Bronze Corp.
General Alloys Co.
General Bronze Corp.
Gorham Mfg. Co., The
Harvard Lock Co.
Harvill Corp.
Hills-McCanna Co.
Howard Fdry. Co.
Jefferson Brass Foundry Co.
Johnson Bronze Co.
Kay-Brunner Steel Prods., Inc.
Kell & Son, Inc.
Kindt-Collins Co.
Kinney Aluminum Co.
Kinney Engrg. Co.
Kirsten Pipe Co.
Lake City Malleable Co., The
Lebanon Steel Foundry
Light Alloys Mfg. Co., The
Lights, Inc.
Lobdell-Emery Mfg. Co., The
Lumen Bearing Co.
Maine Industries Co.
Major Aircraft Foundry
Manufacturers' Iron Fdry, Inc.
Maryland Sanitary Mfg. Corp.
Maytag Co., The
Meehanite Metal Corp.
Metal Fabricators, Inc.
Monarch Alloys Co.
Mueller Brass Co.
Muskegon Piston Ring Co.
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North Jersey Foundry Co., Inc.
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FOR VICTORY BUY WAR BONDS AND STAMPS

Army-Navy "E" Award received Jan. 12, 1943. White Star, for continued high production, received Oct. 30, 1943.

ACME Pattern and Tool Company, Inc.
DAYTON, OHIO

HEAT-TREATED ALUMINUM CASTINGS . . . PATTERNS . . . TOOLS
TOOL DESIGNING . . . PRODUCTION PROCESSING

OFFICIAL U. S. NAVY PHOTO

Out of the Mouths of Ugly Ducklings

FROM ATTU to Africa, from Kiska to Sicily, from Munda to New Britain, LSTs, vital units of America's great fleet of landing craft, have won laurels in a new art of warfare.

These "Ugly Ducklings," as they are known affectionately to the men who work them beachward in the face of enemy gunfire, are one of the most startling types of ship the war has produced.

Born of American ingenuity along the banks of the Mississippi, the LST (Landing Ship, Tank) was only on the drawing boards a mere two years ago. The first model was completed in October, 1942. Yet so vital are these "Ugly Ducklings" in today's amphibious warfare that production of landing craft has been given an overriding priority over all other urgency programs.

Knowing the vital importance of absolutely accurate navigation and trustworthy steering, our Navy equips every LST with the Sperry GYROTRONIC Compass, the famous Mark XIV. And as a result of experience gained in Africa and in the Pacific, the Sperry Electric Follow-Up Steering Control is specified for those currently being delivered to the Navy.

Such large numbers of these two precision devices (designed, developed, and manufactured by Sperry) are now being used that no one company can possibly produce them all. So, Multiscope, Inc., of Coffeyville, Kansas, is making the complete Steering Control for Sperry under subcontract, while the Dodge Division of Chrysler Corporation is helping to supply quantities of Sperry Gyro-Compasses, under prime contract to the Navy.

TODAY, this minute, these gallant LSTs are making history . . . landing tanks and men on enemy-held beaches . . . and landing them exactly where and when they are scheduled to be landed.

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Pennsylvania Fdry. Supply & Sand
Permold Co., The
Phillips Bronze Corp.
Potter & Rayfield, Inc.
Progressive Brass Mfg. Co.
Reliable Metal Novelty Co.
Reynolds Metals Co.
Ritter Co., Inc.
Robins Conveyors, Inc.
Rockford Brass Works
Ross-Meehan Foundries
Scott Aviation Corp.
Shenango-Penn Mold Co.
Sibley Mach. & Fdry.
Spencer Heater Div.
Springfield Brass Co.
Springfield Bronze & Aluminum
Standard Casting Corp.
Superior Brass Co., The
Tex Machine Co.
True Alloys, Inc.
Turner Brass Works, The
U. S. Pipe & Mfg. Co.
Veeder-Root, Inc.
Washington Iron Works
Wellman Bronze & Aluminum
Western Die Casting Co.
Wooster Brass Co., The
Yates-American Machine Co.
York Safe & Lock Co.
Zimmerman Steel Casting Co.

14a—CHEMICALS

Baker Chemical Co., J. T.
Croton Chemical Corp.
Elk & Co., Inc., B. R.
Permutit Corp.
Turco Prods., Inc.
U. S. Industrial Chem., Inc.

15—CLOTHING & PILOT EQUIPMENT

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Aeronautical Trading Co.
Aircraft Appliance Corp.
American Optical Co.
Appel & Co., Inc., S.
Armstrong Aircraft Co.
Aviquips, Inc.
Bausch & Lomb Optical Co.
Beck Distributing Corp.
Berlin Tanning & Mfg. Co.
Chicago Uniform & Co.
Craddock Uniforms
Church Co., Inc., Edmund T.
Colvinex Corp.
Culver Mfg. Co., Inc.
Deacon Bros., Ltd.
Decker Co., Richard M.
Ducomun Co., M.
Duplan Corp.
Du Pont de Nemours & Co., Inc., E. I. (Wilmington)
Elgin National Watch Co.
Fashion Frocks, Inc.
Firestone Aircraft Co.
Firestone Rubber & Latex
General Electric Co.
Gerber Mfg. Co.
Goggle Parts Co., The
Goodyear Tire & Rubber Co., Inc.
Hinson Mfg. Co., The
Hodgman Rubber Co.
Jaeger Watch Co.
Jardur Import Co.
Joyce Aviation, Inc.
Kaufmann & Co., Inc., K.
Lee Company, Inc., The H. D.
Lion Uniform Co.
Marathon Rubber Prods Co.
Menihan Corp., J. G.
Milburn Co.
Nunally & McCrea Co.
Peerless Novelty Co.
Permochart Co., The
Perry Sportswear, Inc.
Pierce Watch Co., Inc.
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Popular Mfg. Co.
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Resistoflex Corp.
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Sellstrom Mfg. Co.
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Springdale Finishing Co., Inc., The
Springfield Upholstery & Awning
U. S. Rubber Co.
Univis Lens Co., The
Wilber & Son
Willis & Geiger, Inc.
Wilson Products, Inc.
Wollensak Optical Co.
Zip-A-Bag Corp.

16—COMMUNICATIONS SYSTEMS & PARTS

A.B.C. Products Inc.
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Aeronautical Radio Mfg. Co.
Aerovox Corp.
Airadio, Inc.
Air Associates Inc.
Air Communications, Inc.
Air Radio & Instrument Corp.
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Aircraft Instrument Service, Inc.
Aircraft Radio Corp.
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Allied Radio Corp.
American Phenolic Corp.
American Radio Mfg. Co.
Amertype Recordgraph Corp.
American Transformer Co.
Andrews Laboratories
Astatic Corp., The
Atlas Tool & Designing Co.
Automatic Electric Co.
Aviometer Corp.
Bassett, Inc., Rex
Bendix Aviation, Ltd.
Bendix Radio Div.
Bliley Electric Co.
Boes Co., W. W.
Booton Radio Corp.
Camfield Mfg. Co.
Cardwell Mfg. Co., The A. D.
Carter Motor Co.
Chicago Metal Hose Corp.
Clarostat Mfg. Co., Inc.
Collins Radio Co.
Connecticut Telephone & Electric
Corning Glass Works
Crosley Corp., The
Crystal Prods., Inc.
Daven Co., The
Deagen, Inc., J. C.
Delco Radio Div., General Motors
Deutschmann Corp., Tobe
Dongan Elec. Mfg. Co.
Doolittle Radio, Inc.
DuMont Laboratories, Inc., Allen
Edwards and Co., Inc.
Eitel McCullough, Inc.
Electro Products Labs.
Electrolux Corp.
Electronic Laboratories, Inc.
Electronic Specialty Co.
Erie Resistor Corp.
Farnsworth Television & Radio
Federal Telegraph Co.
Federal Telephone & Radio Corp.
Ferranti Electric, Inc.
Finch Telecommunications, Inc.
Fisher Research Lab.
Friez Instrument Div.
Galvin Mfg. Co.
General Communications Co.
General Electric Co.
General Instrument Corp.
General Radio Co.
Gibson, Inc.
Gray Mfg. Co., The
Gray Radio Co.
Guided Radio Corp.
Hallicrafter Co., Inc., The
Hammarlund Mfg. Co., Inc.
Hardwick, Hindle, Inc.
Harvey Radio Laboratories, Inc.
Harvey-Wells Communications
Heath Co.
Heintz & Kaufman, Ltd.
Heyer Products Co., Inc.
Hygrade Sylvania Corp.
Hytron Corp.
International Resistance Co.
International Tel. & Tel. Corp.
Islip Radio Mfg. Co.
Isolantite, Inc.
Jefferson-Travis Radio Mfg. Corp.
Johnson Co., E. F.
Jowein, Inc.
Kellogg Switchboard & Supply
Ken-Rad Tube & Lamp Corp.
Kenyon Transformer Co., Inc.
Kulka Elec. Mfg. Co., Inc.
Langevin Co., Inc., The
Lear Avia., Inc.
Liberty Motors & Engrg. Corp.
Librascope, Inc.
Lights, Inc.
Link Aviation Devices, Inc.
Littelfuse, Incorporated
Lowry Electrical Co., Inc.
Mec-Rad Div. Black Industries
Mercury Aircraft, Inc.
Micamold Radio Corp.
Molded Insulation Co.
Monitor Piezo Prod. Co.
Murdock Mfg. Co., Wm. J.
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National Union Radio Corp.
Ohio Carbon Co., The
Operadio Mfg. Co.
Orange Screen Co.
Oxford-Tartak Radio Corp.
Panoramic Radio Corp.
Peerless Elec. Prod. Co.
Permoflux Corp.
Philco Corp.
RCA Victor Div.
Radio Frequency Laboratories
Radio Receptor Co., Inc.
Radio Wire Television, Inc.
Reisner & Co., Inc.
Reynolds Molded Plastics
Rieber, Inc., Frank
Roburn Agencies, Inc.
S. W. Inductor Co.
St. Louis Radio Engineering Co.
Searle Aero Industries, Inc.
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Sickles Co., The F. W.
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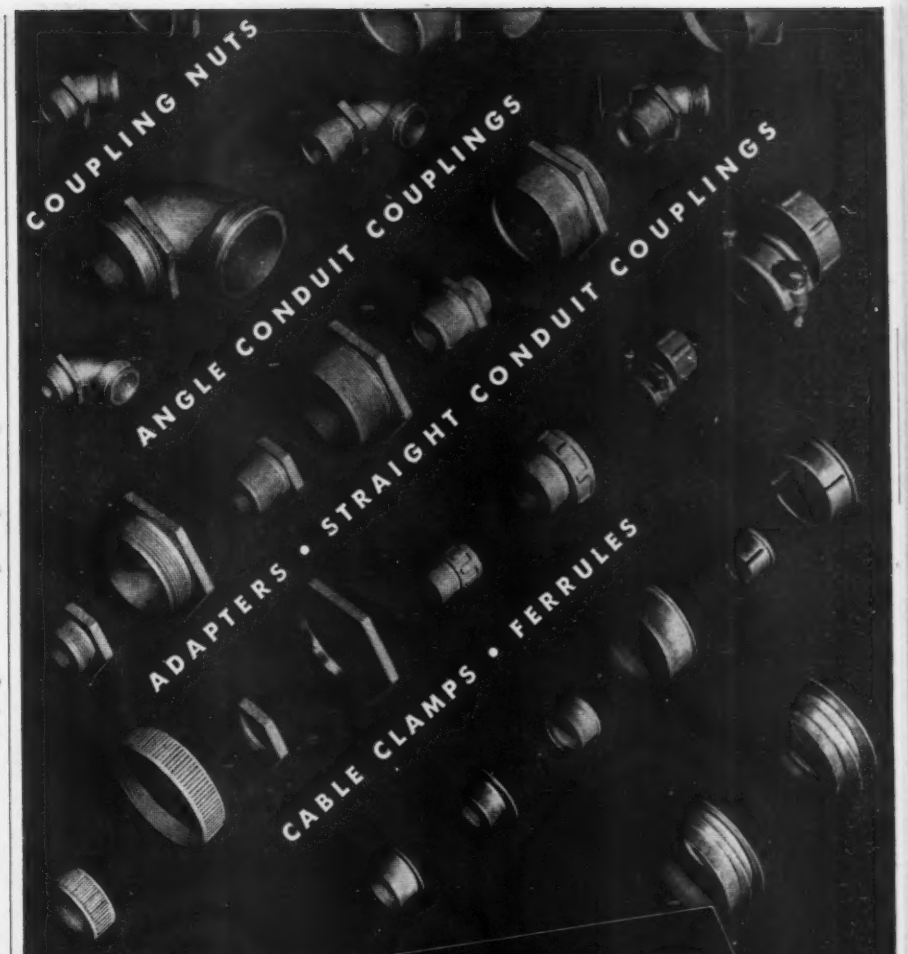
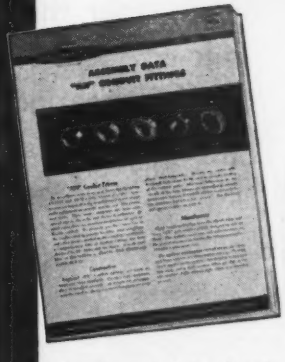
Stoddart Aircraft Radio Co.
Stratosearch, Inc.
Stromberg Carlson Tel. Mfg. Co.
Tel. Autograph Corp.
Teleregister Corp., The
Televiso Products, Inc.
Tex Machine Co.



A-N Conduit Fittings
for
Aluminum Shielding Conduit
ALL STYLES · · · ALL SIZES



• Amphenol builds conduit fittings in accordance with Army-Navy specifications AN-9534 and AN-W-C-591 for use with flexible, synthetic covered flexible, rigid conduit and all types of cable.

The Amphenol A-N Conduit Fitting line is extensive—fittings are available from stock to properly join connectors to the conduit and to provide runs, turns, couplings, and other fitting arrangements needed in the complete installation. Fitting sizes correspond to all standard conduit specifications.

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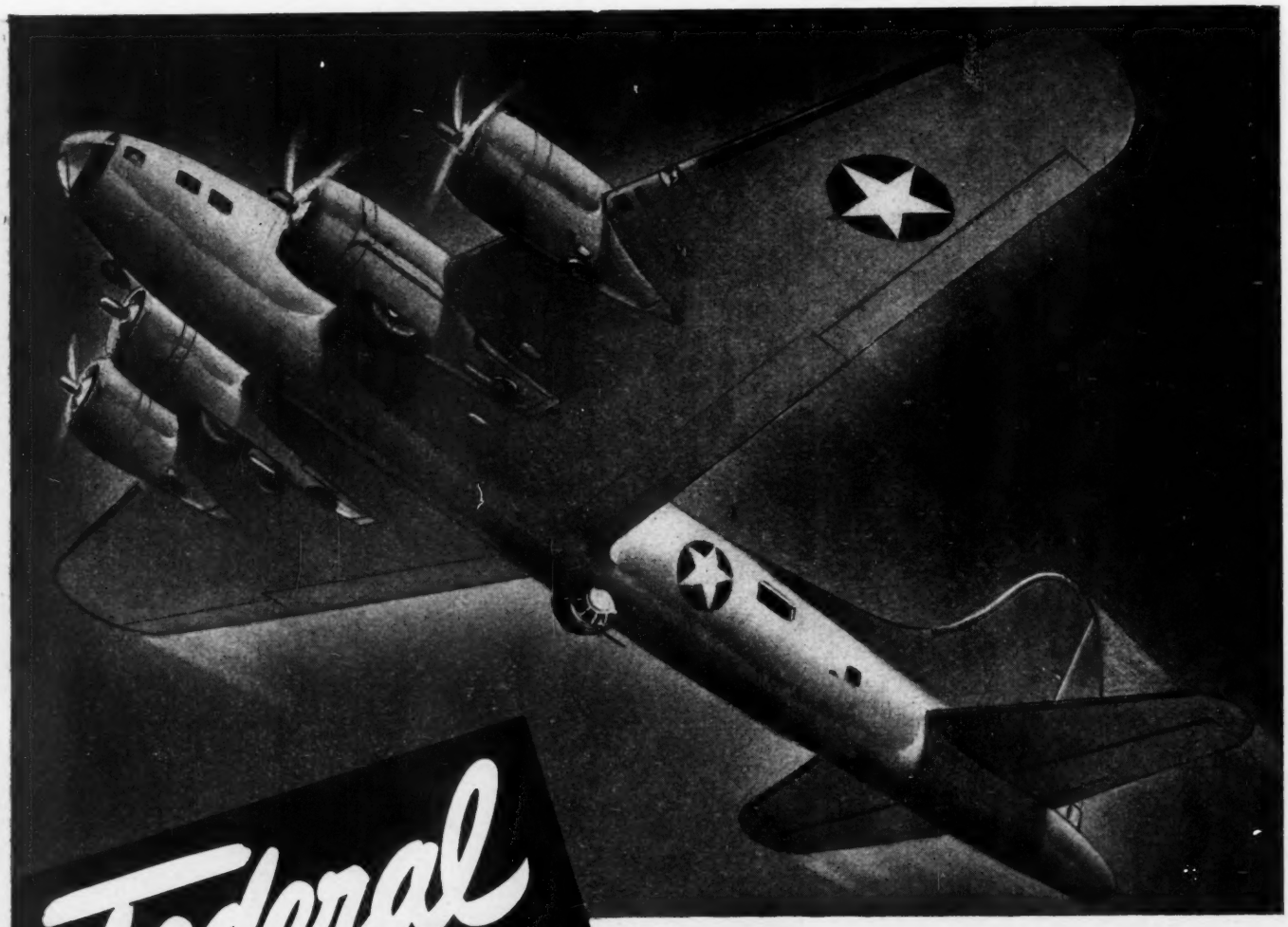
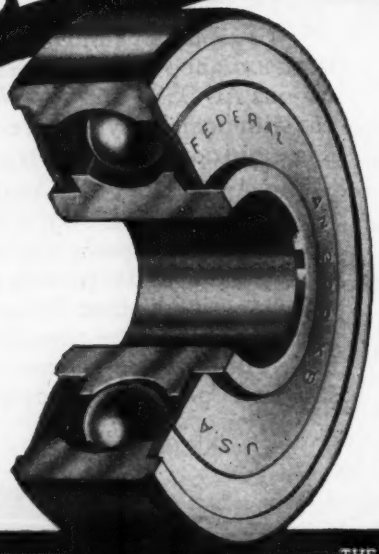


Federal aircraft BEARINGS



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Zophar Mills, Inc.

17—COMPRESSORS, AIR

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Smith-Courtney Co.
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Stevens, Inc., Fred B.
Sturtevant Co., B. F.
Sullivan Machinery Co.
Tull Metal & Supply Co., J. M.
U. S. Air Compressor Co.
U. S. Steel Supply Co.
Wayne Pump Co., The
Westinghouse Air Brake Co.
Worthington Pump & Mach. Corp.
Yeoman Bros. Co.

18—CONSTRUCTION—AIRPORT & BUILDINGS

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American Foundry & Furnace Co.
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Havens Structural Steel Co.
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Homasote Co.
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Ingalls Iron Works Co.
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Iron City Tool Works
Irvington Steel & Iron Wks.
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Mall Tool Co.
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Maryland Metal Building Co.,
Masonite Corp.
Morris Wheeler & Co.
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Pacific Iron & Steel Company
Pittsburgh-Des Moines Steel Co.
Portland Cement Assoc.
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Rilco Laminated Products, Inc.
Robertson Co., H. H.
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Starbird, Geo. A.
Stow Mfg. Co., Inc.
Summerbell Roof Structures
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Timber Structures, Inc.
Truscon Steel Co.
Universal Bldg. Prod. Co.
Universal Engr. Corp.
Voight & Son Co., R.
Ziebarth Co., Fritz

19—CONTROLS & ASSEMBLIES

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Aeronautical Trading Co.
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Air Cruisers, Inc.
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Aircraft & Marine Specialty Co.
Aircraft Products, Inc.
Aircraft Specialties Co.
Alco Valve Co.
All American Aircraft Products
Allied Aircraft Co.
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American Hard Rubber Co.
Arens Controls, Inc.
Atlas Tool & Designing Co.
Autoflight Corp.
Automatic Electric Co.
Automatic Electric Mfg. Co.
Aviation Engineering, Inc.
Aviation Parts, Inc.
Aviquipo, Inc.
Baldwin-Duckworth Div.
Barber-Colman Co.
Barco Mach. Prods. Co.
Bendix Aviation, Ltd.
Bendix Products Div.
Breeze Corps., Inc.
Bristol Co.
Cash Co., A. W.
Chain Belt Co.
Char-Gale Mfg. Co.
Charles Mfg. Co.
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Clarke Aero-Hydraulics, Inc.
Clifford Mfg. Co.
Columbia Aircraft Industries
Cosco Mfg. Co.
Cunningham Hall Aircraft Corp.
Davis-Westholt, Inc.
Decker Co., Richard M.
Defiance Automatic Screw Co.
DeJur-Amsco Corp.
Del-Air Corp.
Delavan Engineering Co.
Diamond Chain & Mfg. Co.
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Dolan Aircraft Mfg. Co.
Doolittle Radio, Inc.
Electric Sprayit Co., The
Engineering Development Assoc.
Formica Insulation Co., The
Frankfort Sailplane Co.
Fulton Sylphon Co., The
General Communications Co.
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Goodyear Aircraft Corp.
Grammes & Sons, Inc., L. F.
Guardian Electric Co.
Gwilliam Co., The
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Harvard Lock Co.
Harvey Machine Co., Inc.
Hockaday Aircraft Corp.
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Hyland Mach. Co.
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Iron Fireman Mfg. Co.
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Luscombe Airplane Corp.
Lyon Metal Products, Inc.
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Main Machine Co.
Martin-Parry Corp.
Martin & Swartz, Inc.
Mason Co., Thomas
McInerney Plastics Co.
Mercury Aircraft, Inc.
Metal Products Engrg., Inc.
Miller-Robinson Co.
Minneapolis-Honeywell Regulator
Moore-Eastwood Co.
Moss Tool Co.
National Machine Products
National Pneumatic Co.
Ohmer Register Co.
P-V Engineering Forum, Inc.
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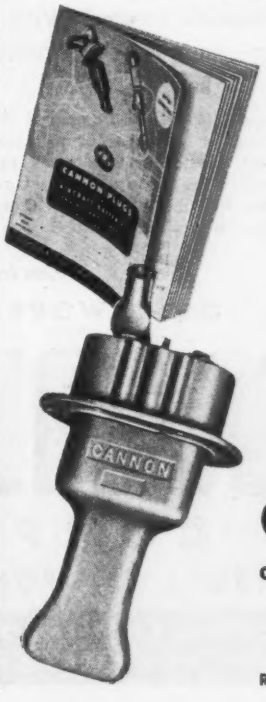

CANNON BATTERY CONNECTOR—GB-3-34B Receptacle and GB-3-21B Plug shown at left are adapted to general industrial uses as well as quick disconnect of engine starting units in aircraft. This Cannon line covers a wide variety of types which are listed in the New Battery Connector Bulletin—free upon request. Address Department A-110, Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, California.

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Canadian Factory and Engineering Office:
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21—COWLING

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22—DE-ICING EQUIPMENT

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Infra-Red Engineers & Designers
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Lear Avia., Inc.
Minneapolis-Honeywell Regulator
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Sorensen & Co., Inc.
Solar Aircraft Co.
Southern California Air Parts
Special Mach. Tool Engrg. Wks
Stanley Wks., The
Steel Forming Corp.
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Summit Ind. Prod. Co.
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Olofsson Tool & Die Co.
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Pacific Iron & Steel Co.
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Stafford Tool Die & Machine Co.
Supreme Tool & Die Co.
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Wales-Strippitt Corp.
Wellman Bronze & Aluminum
Western Die Casting Co.
Williamsport Die & Mach. Co.
Western Forge & Tool
Winter Bros. Co.
Wrought Washer Mfg. Co.

22(b)—DISTRIBUTORS, SEE 52

23—DRAFTING ROOM SUPPLIES

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24—ELECTRICAL EQUIPMENT —FOR AIRCRAFT

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Delco-Remy Div. General Motors
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Dumore Co.
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Eicor, Inc.
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Electric Auto Lite Co.
Electric Products Co.
Electric Service Supplies Co.
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Friden Calculating Mach. Co.
Fulton Co., The
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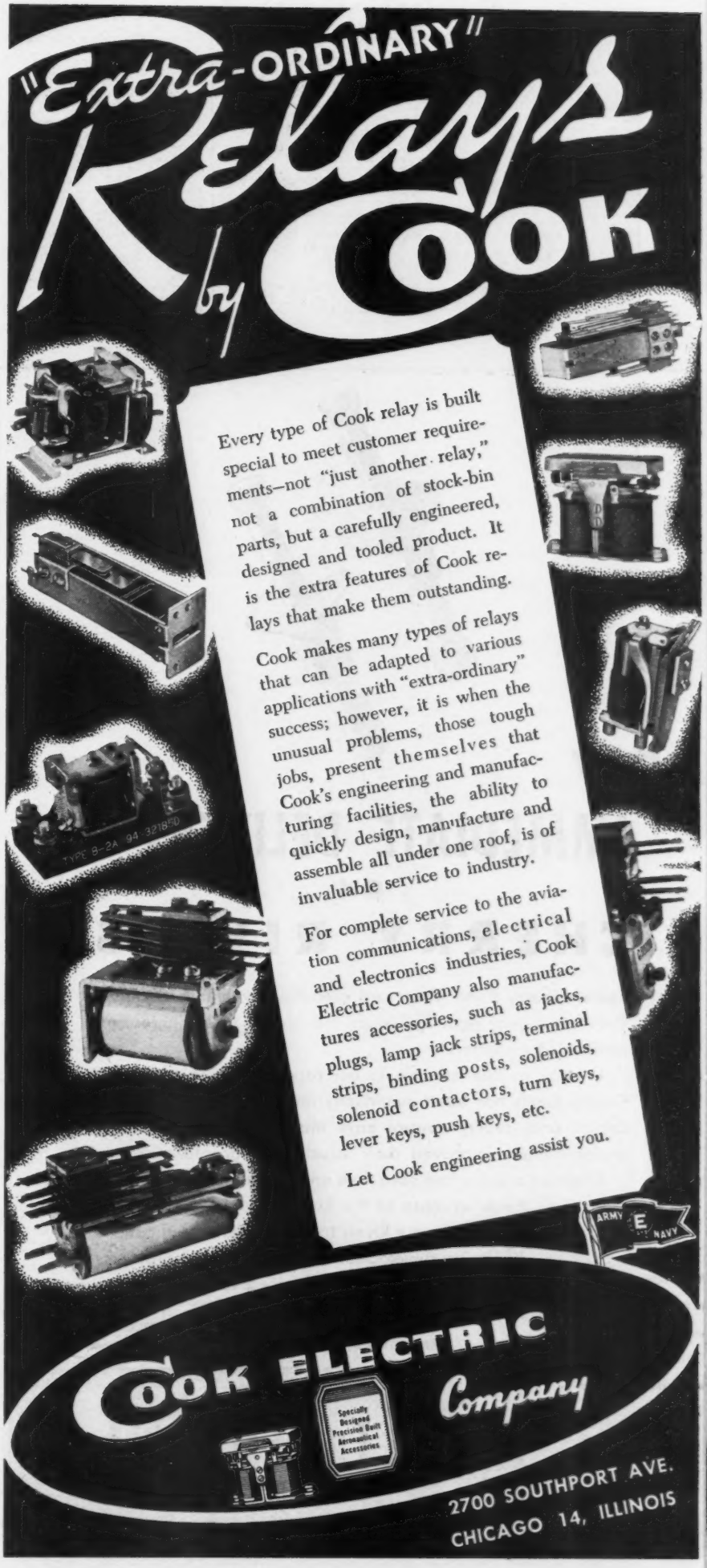
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Wilcolator Co., The
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Zell Corp.

25—ELECTRICAL EQUIPMENT —GROUND

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Gray Mfg. Co., The
Guardian Electric Co.
H-B Electric Co.
Hagedorn Engineering
Hart Manufacturing Co., The
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Harvey-Wells Communications, Inc.
Hertner Electric Co., The
Heyer Products Co., Inc.
Holtzer Cabot Electric Co., The
Hopax Devices, Inc.
Ideal Electric & Mfg. Co.
Industrial Controller Div.
Industrial Screw & Supply Co.
Instrument Resistors Co.
Internat'l Derrick & Equip. Div.
International Resistance Co.
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Kellogg Switchboard & Supply
Kelley-Koett Mfg. Co., The
Keystone Carbon Co., Inc.
Kliegl Bros.
Kuhlman Elec. Co.
Kulka Elec. Mfg. Co., Inc.
LaMar Indicating Fuse Corp.
Langevin Co., Inc., The
Larrimor Sales Co.
Lawrence Aeronautical Corp.
Leland Elec. Co., The
Lewis Engrg. Co., The
Lister Blackstone, Inc.
Littlefuse Co.
Lowry Electrical Co., Inc.
McColpin-Christie Corp., Ltd.
McInerney Plastics Co.
Maine Industries Co.
Martindale Elec. Co., The
Merrill Engrg. Laboratories
Micamold Radio Corp.
Milwaukee Elec. Tool Corp.
Mines Equipment Co.
Moisture Register Co.
Molded Insulation Co.
Morganite Brush Co.
Mossman, Inc., Donald P.
Munsell & Co., Eugene
National Electric Products Corp.
Ogden Filter Co.
Ohmite Mfg. Co.
Packard Mfg. Corp.
Pass & Seymour, Inc.
Patton-MacGuyer Co.
Peerless Elec. Prod. Co.
Pennsylvania Transformer Co.
Persons Corp., L. M.
Phillips Aviation Co.
Pioneer-Gen-E-Motor
Poulsen & Nardon, Inc.
Radio City Prods. Co.
Reuther Equip. & Paint Co.
Rieber, Inc., Frank
Ritter Co., Inc.
Roburn Agencies, Inc.
Rocky Mountain Steel Prods.
Rowe Industries
Rusgreen Mfg. Co.
St. Louis Engineering Co.
Saylor Elec. Prods. Corp.
Scientific Radio Products
Searle Aero Industries, Inc.
Selenium Corp. of America
Seymour Mfg. Co., The
Sherman Mfg. Co., H. B.
Sigma Instruments Inc.
Sola Electric Co.
Speer Carbon Co.
Spencer Thermostat Co.
Square D Co.
Stackpole Carbon Co.
Standard Elec. Time Co., The
States Co., The
Steel & Tubes Div.
Sticht Co., Inc., Herman H.
Superior Carbon Prod., Inc.
Switch & Panel Div.
Techtmann Industries, Inc.
Thompson Electric Co.
Thwing-Albert Instrument Co.
Tietzmann Engrg. Co.
Toledo Standard Commutator Co.
Trumbull Electric Mfg. Co.
Turtle & Hughes, Inc.
U. S. Graphite Co., The
United States Mortors Corp.
Waite Mfg. Div.—Picker X-Ray
Ward Leonard Elec. Co.
Weidenhoff, Inc., Joseph
Welded Aircraft Parts Co.
Westinghouse Elec. & Mfg. Co.
Westinghouse Electric & Mfg. Co. (Lima Works)
Wheelco Instruments Co.
Whitaker Battery Supply
Wiegand Co., Edwin L.
Wilcolator Co., The
Wilcox Electric Co., Inc.

26—ENGINE PARTS & ACCESSORIES

A & F Aluminum Prods. Co.
Accmatool Co., Inc.
Accurate Tool Co., Inc.
Ace Manufacturing Corp.
Adel Precision Products Corp.
Aerial Mach. & Tool Corp.
Aeromotive Prods. Corp.
Aero Supply Mfg. Co., Inc.
Aeronautical Mfg. Corp.
Aeronautical Products, Inc.
Aeronautical Trading Co.
Aeroquip Corp.
Agerstrand Corp.
Air Associates, Inc.
Air-Maze Corp.
Aircraft Instrument Service, Inc.
Aircraft Mechanics, Inc.
Aircraft Parts Production Corp.
Airesearch Mfg. Co.
Alexander Tool & Mfg. Co.
Allison Div., General Motors
Aluminum Gds. Mfg. Co.
American Air Filters Co., Inc.
American Auto Parts Co., The
American Brake Shoe Co.
American Cast Iron Pipe Co.
American Machine & Metals, Inc.
American Non Gran Bronze Corp.
American Safety Razor Co.
American Tube Bending Co.
Apex Tool Co., Inc., The
Arnolt Motor Co.
Aro Equipment Corp.
Atlantic Diesel Corp.
Automatic Burner Corp.
Aviation Parts, Inc.
B. H. Aircraft Co., Inc.
Balboni, Arrigo, Airplane Supplies
Barco Mach. Prods. Co.
Bethlehem Equip. Corp., Ltd.
Borg Warner Corp.
Bowling Green Rubber Co.
Breeze Corps., Inc.
Bridgeport Worn & Gear Mfg. Co.
Brown Lathe & Tool Co.
Buda Co.
Burgess-Norton Mfg. Co.
Burris of Essex County, Inc.
Bush Mfg. Co.
Cadillac Motor Car Div.
Cantin Co., Inc., Eugene
Carpenter Mfg. Co., The, E. W.
Caterpillar Military Engine Co.
Centerless Grinding Co.
Chamberlin Metal Weatherstrip
Chicago Hardware Foundry Co.
Chicago Pneumatic Tool Co. (Franklin, Pa., Div.)
Cleveland Wire Cloth & Mfg. Co.
Clifford Mfg. Co.
Columbia Aircraft Products, Inc.
Columbia Stamping & Mfg. Corp.
Connecticut Hard Rubber Co.
Continental Aviation & Engrg.
Continental Motors Corp.
Crowe Name Plate & Mfg. Co.
Cunningham Hall Aircraft Corp.
Cuno Engrg. Corp., The
Daworth Eng. & Mfg. Co.
DeBothezat Ventilating Equip.
Del-Air Corp.
Detroit Gear Aircraft Parts Div.
Dix Machine Works
Dollinger Corp.
Dycer Aviation Supplies
Eaton Mfg. Co. (Cleveland)
Eclipse Pioneer Div.
Ertel Mach. Co.

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Raiding Party BY JAMES M. SESSIONS

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Federal-Mogul Corp.
Fernholtz Machinery Co.
Foote Bros. Gear & Mach. Corp.
Fram Corp.
Frantz Co., Inc., S. G.
Freeport Machine Works, Inc.
Fulton Sylphon Co., The

Garrett Corp., The
Gasket Shop, The
Gets Bros. Mfg. Co.
Graham-Paige Motors Corp.
Greist Mfg. Co., The
Gurberson Diesel Eng.

Hagedorn Engineering
Harrison Radiator Div.
Harvey Machine Co., Inc.
Haynes Stellite Co.
Hi Standard Mfg. Corp.
Hockaday & Phillips, Inc.
Howe Ice Machine Co.
Hudson Motor Car Co.

Ideal Roller & Mfg. Co.
Imperial Brass Mfg. Co., The
Indiana Gear Wks.
Industrial Washing Mach. Corp.
Industrial Wire Cloth Prods.

Jack & Heintz, Inc.
Jackson Crankshaft Div.,
Johns-Manville

Kahrs Engrg. Mach. Co.
Kelsey Hayes Wheel Co.
Kenyon Instrument Co.
Kickshaefer Mfg. Co.
Kinney Engrg. Co.
Koehler Aircraft Products Co.
Kohler Co.
Kux Machine Co.

L & W Parts Co.
Lane-Wells Co.
LaSalle Furniture Co.
Levene Motor Co.
Lewis & Co., Inc., Joseph E.
Liberty Engr. Co.
Livingston Machine Shop
Lunkenheimer Co., The

M B Mfg. Co., Inc., The
McCullough Aircraft Co.
McCulloch Engineering Corp.
McInerney Plastics Co.
McQuay-Norris Mfg. Co.
MacEwan & Smith, Inc.
Maine Industries Co.
Marquette Metal Prods. Co., The
Martin & Schwartz, Inc.
Menasco Mfg. Co.
Menaugh-Dutterer Co.
Michiana Prods. Corp.
Michigan Engine Valve Co.
Michigan Wire Cloth Co.
Moore-Eastwood Co.
Morton Mfg. Co.
Moss & Co., Henry
Mullenbach Electrical Mfg. Co.

Napoleon Products Co., The
National Bronze & Aluminum
National Pneumatic Co.
Newark Wire Cloth Co.
Northern Aircraft Prods. Div.
Northwest Air Service, Inc.

Ohio Crankshaft, Inc.
Ohio Piston Co., The
Oliver Farm Equip. Co.

Pacific Piston Ring Co.
Panelyte Div.
Paramount Textile Machy Co.
Parker Stamp Wks., Inc., The
Peerless Mach. Co.
Pipe Machy. Co., The
Pitkin Mach. Wks.
Precision Aero. Corp.
Precision Products, Inc.
Prudential Mach. Corp.
Purolator Prod., Inc.

Raybestos Manhattan, Inc.
Reisner & Co., The, W. H.
Reliable Mach. Shop
Reliable Spring & Wire Forms Co.
Reliance Machine & Mfg. Co.
Republic Aircraft Products Div.,
Rheem Mfg. Co.
Riehle Mach. Co.
Ripley Mfg. Co.
Robbins Co., J. R.
Robertshaw Thermostat Co.
Rochester Mfg. Co.
Rockwood Sprinkler Co.
Romec Pump Co.
Rowe Industries
Rozum Motor Co.

Saratoga Mfg. Co.
Schwitzer-Cummins Co.
Simplex Prod. Corp.
Skinner Purifiers, Inc.
Solar Aircraft Co.
Solo Prod. Corp.
Sparkes Mfg. Co.
Sparkler Mfg. Co.
Special Mach. Tool Engrg. Wks.
Speedometer Service & Access.
Spier Aircraft Corp.
Standard Motor Co.
Star Mach. & Tool Co.
Steel Products Engrg. Co., The
Stewart Warner Corp.
Stow Mfg. Co., Inc.

Taft Peirce Mfg. Co.
Taylor Machine Co., The
Teleoptic Co., The
Thompson Products, Inc.
Titan Valve & Mfg. Co.
Torrance Precision Mfg. Co.
Trader-Aero Supply, Bob
Transcontinental Machine & Tool
Tube Turns, Inc.
Tyler Co., W. S.
Tyson Bearing Co.

U. S. Graphite Co., The
U. S. Hoffman Machy. Corp.
United Aircraft Products, Inc.
Universal Gear Corp.
Vic Cleaning Mach. Co.
Vickers, Inc.
Wallace Supplies Mfg. Co.
Warner Aircraft Corp., The
Waukesha Motor Co.
Weatherhead Co., The
Welding Machine Mfg. Co.
Western Mfg. & Supply Co.
Wharry & Co., Inc., G. A.
Wheeling Bronze Casting Co.
White Engineering Co.
White-Rodgers Elec. Co.
Wiggins Airways, Inc., E. W.
Wisconsin Motor Corp.
Woodward Governor Co.
Woodworth Co., N. A.
Worcester Stamped Metal Co.
Worcester Pressed Steel Co.
Wrentham Products Co.

York-Shipley, Inc.
Zamax Mfg. Co.

27—EXHAUST SYSTEMS & PARTS

Aero Die & Stamping Co.
Aero Services, Inc.
Aircraft Components, Inc.
Aircraft Development Co.
Aircraft Products, Inc.
Aircraftsmen Co., The
Airesearch Mfg. Co.
Airfan Engineering Co.
Alloy Manufacturing Co., Inc.
American Aviation Corp.
American Central Mfg. Corp.
American Machine & Metals, Inc.
American Tube Bending Co.
Aviation Engineering, Inc.

B. H. Aircraft Co. Inc.
Benson Mfg. Co.
Binks Mfg. Co.
Brady Conveyors Corp., The
Breeze Corps., Inc.
Budd Mfg. Co., Edward G.
Buhl Stamping Co.
Busser Supply Co.

Cantin Co., Inc., Eugene
Chelsea Fan & Blower Co., Inc.
Chicago Metal Hose Corp.
Columbia Stamping & Mfg. Corp.

Davis-Westholt, Inc.
Detroit Sheet Metal Works
DeVilbiss Co., The

Engineering Development Assoc.
Exhaust Fan & Blower Co.

Fernholtz Machinery Co.
Fletcher Aviation Corp.

General Aircraft Equipment, Inc.
Grossman Steel Stair Corp.

Hanlon & Wilson Co.
Hockaday Aircraft Corp.
International Engrs., Inc.
Jensen Mach. Co., Inc.

Kent Co., F. C.
Keystone Aircraft Products, Inc.
MacLeod Co.
Maxim Silencer Co., The
Mayer Mfg. Corp.
Murray Corp. of America
Pollak Mfg. Co.
Prudential Mach. Corp.
Schmieg Industries
Scott Aviation Corp.
Skylark Mfg. Co., Inc.
Solar Aircraft Co.
Standard Electrical Tool Co., The
Steel & Tubes Div.
Sturtevant Co., B. F.

Taylorcraft Avia. Corp.
Thompson Products, Inc.
Tyler Fixture Corp.

U. S. Flexible Metallic Tubing
United Welding & Mfg. Co.
Utility Fan Corp.

Viking Air Cond. Corp.

Walker Mfg. Co.
Walker Mfg. Co. of Wis.
Wallace Supplies Mfg. Co.
White Aircraft Corp.
Worcester Stamped Metal Co.

28—EXTRUSIONS—METAL

Aero Components Mfg. Co.
Airesearch Mfg. Co.
Allied Aircraft Co.
Alpha Metal & Rolling Mills, Inc.
Aluminum Co. of America
American Brass Co., The
American Smelting & Refining
Ampco Metal, Inc.

Blum & Co., Inc., Julius
Bowling Green Rubber Co.

Chase Brass & Copper Co., Inc.
Clifford Mfg. Co.
Colonial Alloys Co.
Conco Engineering Works

Dockson Corp.
Dow Chemical Co.

Extruded Metals Defense Corp.

Gay Engr. Corp of Calif.

Hayes Mfg. Corp.

Knape & Vogt Mfg. Co.

Levene Motor Co.
Longren Aircraft Co.

Martin-Parry Corp.
Metal Products Engrg., Inc.
Metal Specialty Co., The
Mueller Brass Co.

New York Brass & Copper Co.

Petroleum Marketing Co.

Revere Copper & Brass, Inc.
Reynolds Metals Co.

Strickland Aircraft Corp., The

U. S. Rubber

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HONING AND SUPERFINISHING STONES · CUT-OFF WHEELS · INSERTED-NUT DISCS AND CYLINDERS
PORTABLE SNAGGING WHEELS · MOUNTED WHEELS AND POINTS · GRINDING WHEELS

29—FABRICS

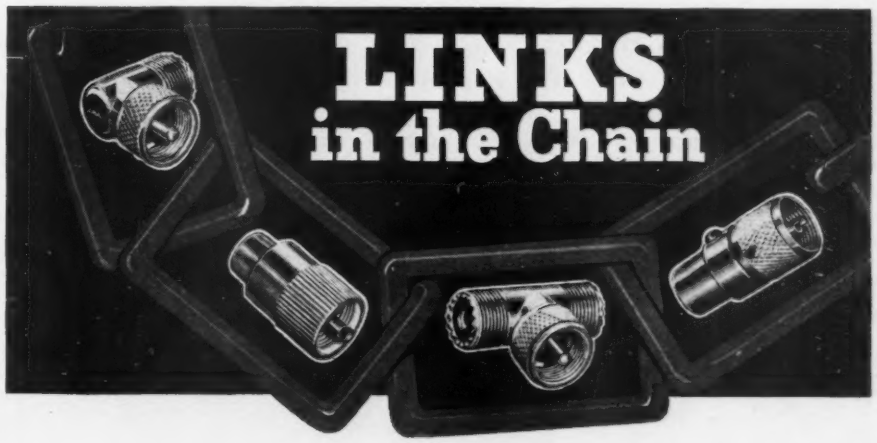
Abeles-Lewit Co., Inc.
Aeronautical Trading Co.
Air Associates, Inc.
Aircraft Appliance Corp.
Aircraft Steel & Supply Co., The
Air Cruisers, Inc.
Air-Parts, Inc.
American Thread Co., The
American Viscose Corp.
Anderson Flax Fiber Co., Inc.
Arbeka Webbing Co.
Aristocrat Narrow Fabric Co.
Associated Suppliers Co.
Athol Mfg. Co.
Atlantic Rayon Corp.
Atlas Asbestos Co.
Atlas Powder Co., Zapon Div.
Aviquipo, Inc.
Backstay Welt Co.
Balboni, Arrigo
Bearse Mfg. Co.
Belco Industries, Inc.
Blanchard Bros. & Lane
Blumenthal & Co., Sidney
Bridgeport Fabrics, Inc.
Burcott Mills
Charles Mfg. Co.
Chase & Co., L. C.
Cincinnati Thread Co., The
Cleveland Tanning Co.
Cluff Fabric Products, Inc.
Collins & Aikman Corp.
Columbus Coated Fabrics Corp.
Comstock & Co.
Conneaut Leather Co.
Cooley, Inc.
Craftex Mills, Inc., of Penna.
Crompton Co. of Rhode Island
Daniels Inc., C. R.
Duer & Sons, Inc., John
Duplan Corp.
Du Pont de Nemours & Inc., E. I. (Wilmington)
Eagle-Ottawa Leather Co.
Electric Auto Lite Co.
Ellis Mills, Inc., A. D.
Erwin Cotton Mills Co., The
Gatke Corp.
General Aircraft Corp.
General Thread Mills, Inc., The
Georgia Webbing & Tape Co.
Goodyear Tire & Rubber Co., Inc.
Gordon-Lacey Chem. Prods. Co.
Grand Rapids Varnish Co.
Hagerstown Leather Co., The
House & Sons, Inc., Chas. W.
Industrial Tape Corp.
Johns-Manville
Keese Engineering Co.
Lachman Co., Inc., Charles
Lackawanna Leather Co., The
Landers Corp., The
Ludlow Mfg. & Sales Co.
Hinson Mfg. Co., The
Holfast Rubber Co., The
Hope Webbing Co.
Kenwood Mills
Laidlow Co., Inc., The
Marathon Rubber Prods. Co.
Massachusetts Mohair Plush Co.
Meyer Thread Co., John C.
Monco, Inc.
National Automotive Fibres, Inc.
Nati. Card, Mat, Board
Pacific Hide & Leather Co., Inc.
Payne & Co.
Peiger McCaw & Co.
Springdale Finishing Co., Inc., The
Sunset Line & Twine Co.
Threads-Inc.
West End Thread Corp., The
Wiggins Airways, Inc., E. W.
Zapon-Keratol
Zapon-Keratol Div.

30—FASTENERS, NUTS, BOLTS, SCREWS & WASHERS

Abeles-Lewit Co., Inc.
Acco Products, Inc.
Active Screw & Mfg. Co.
Actus Prod. Co.
Aero Engineering, Inc.
Aero Products
Aero Screw Co.
Aero Supply Mfg. Co., Inc.
Aeronautical Trading Co.
Air Associates, Inc.
Aircraft Hardware Mfg. Co.
Aircraft Instrument Service, Inc.
Aircraft Industries Corp.
Aircraft Nut Corp.
Aircraft Screw Products Co., Inc.
Aircraft Standard Parts Co.
Aircraft Welded Clamp Co.
Air-Parts, Inc.
Airsealand Aircraft, Inc.
Air Transport Equip., Inc.
Allen Co., Inc., L. B.
Allen Manufacturing Co., The
Altens Fdry. & Mach. Wks.
Aluminum Co. of America
American Chain Div.
American Felt Co.
American Manganese Bronze Co.
American Nut & Bolt Fastener
American Screw Co.
American Stamping Company
Anderson Flax Fiber Co., Inc.
Andrews Hardware & Metal Co.
Anti-Corrosive Metal Products
Arens Controls, Inc.
Atlas Bolt & Screw Co., The
Automatic Screw Machine Prods.
Automotive Hardware, Inc.
Automotive Rubber Co.
Autoscrew Co.
Auto-Soler Company
Aviation Parts, Inc.
Aviation Supply Co.
Aviquipo, Inc.
Bailey Co., Inc.
Bardwell & McAlister, Inc.
Barnes-Gibson-Raymond Div.
Beall Tool Div. (Hubbard & Co.)
Ben Mfg. Co., The
Bethlehem Steel Co.
Beverly Grinding Service
Bland Precision Prods.
Booth Felt Co., Inc.
Boots Aircraft Nut Corp.
Bridgeport Worm & Gear Mfg.
Brightman Nut & Mfg. Co.
Bristol Co.
Broad Brook Co.
Brooks & Sons, M. S.
Brown-McLaren Mfg. Co.
Buffalo Bolt Co.
Burklyn Co.
Busser Supply Co.
Butcher & Hart Mfg. Co.
Caley & Co., W. J.
Camloc Fastener Corp.
Central Screw Co.
Chamberlain Co.
Chandler Prods. Corp.
Chase Brass & Copper Co., Inc.
Chicago Screw Co.
Cinch Mfg. Corp.
Clancy, Inc., J. R.
Clark Iron Wks., C. N.
Cleveland Cap Screw Co.
Collins-Powell Co.
Collord, Inc.
Columbia Aircraft Products, Inc.
Continental Screw Co.
Corbin Cabinet Lock Div.
Corbin Screw Corp.
Crown Fastener Div.
Cuyahoga Spring Co.
Delavan Engineering Co.
Detroit Die Set Corp.
Detroit Harvester Co.
Detroit Stamping Co.
Diamond Screw Products Co.
Dill Mfg. Co., The
Downs-Smith Brass & Copper
Dresser Mfg. Co.
Duer & Sons, Inc., John
Dunbar Kapple, Inc.
Dunne Rubber Co.
Dzus Fastener Co., Inc.
Eaton Mfg. Co.
Eaton Mfg. Co., Reliance Div.
E F G Engineering Works, Inc.
Elastic Stop Nut Corp.
Erie Concrete & Steel Supply Co.
Everready Hardware Mfg. Co., Inc.
Excelsior Leather Washer Mfg.
Exhaust Fan & Blower Co.
Ferry Screw Products, Inc., E.W.
Forrest Mfg. Co.
Franklin Fibre-Lamitex Corp.
Freeport Machine Works, Inc.
Gagnier Fibre Products Co.
Gardner Co., J. R.
Garrett Co., Geo. K.
General Automatic Corp.
Grand Specialties Co.
Greer Co., Frederic
Greist Mfg. Co., The
Groov-Pin Corp.
Guarantee Specialty Mfg. Co.
H & H Tool Co., The
Handy Mfg. Co.
Hartford Mach. Screw Co.
Harvey Machine Co., Inc.
Hassall, Inc., John
Heim Co., The
Hi Standard Mfg. Corp.
Highbridge-International Co.
Hindley Mfg. Co.
Hockaday & Phillips, Inc.
Holo-Krome Screw Corp.
Houde Engrg. Div.
Hubbard Spring Co., M. D.
Ideal Clamp Mfg. Co., Inc.
Industrial Screw & Supply Co.
International Screw Co.
Jolley Co., J. H.
Josephson & Sharp Mfg. Co.
Kaynar Mfg. Co.
Kellems Co.
Kenyon Instrument Co.
Keystone Bolt & Nut Corp.
Kreger Mfg. Co., The, L. F.
L & W Parts Co.
Lackner Co., Inc., The
Laminated Shim Co., Inc.
Lamson & Sessions Co., The
Long, S. A. Co., Inc., The
Lebanon Screw Co.
Lisle Corp.
Livingston Machine Shop
Los Angeles Heavy Hardware Co.
Lowry Electrical Co., Inc.
M & T Precision Parts Co.
McIlwee Machine Shop
Machined Parts Corp.
Manufacturers Screw Products
Marlin Firearms Co.
Marman Products Co., Inc.
Massachusetts Mach. Shop, Inc.
Master Aircraft Parts Co.
Master Products Co., The
Mead Gliders & Specialties Co.
Mervin Industries, Inc.
Metal Goods Corp.
Metal Products Engrg., Inc.
Mid-West Screw Products Co.
Milford Rivet & Mach. Co.
Monarch Metal Weatherstripp. Co.
Moss & Co., Henry
Myers, Jr., Inc., L. A.
National Lock Co.
National Motor Bearing Co., Inc.
National Needle Co.
National Prod. Co., The
National Screw & Mfg. Co., The
Neal & Brinker Co.
Neal Co., Inc., R. C.
New England Screw Co.
New Plastic Corp.
Newman Mfg. Co., Inc.
Nigg Engr. Co.
Ohio Aircraft Hadw. Co.
Ornitz & Co., Edward M.
Pacific Cut Washer Co.
Pacific Screw Products Corp.
Packless Metal Prods. Corp.
Palnut Co., The
Parker Co.
Parker-Kalon Corp.
Payne & Co.
Peters Implement Co.
Pheoll Mfg. Co.
Phila. Steel & Wire Corp.
Phillips Screws
Pipe Machy. Co., The
Pitkin Mach. Wks.
Plastic Prod. Co.
Pollak Mfg. Co.
Poulsen & Nardon, Inc.
Precision Products, Inc.
Prestole Div. Detroit Harvester
Printloid, Inc.
Products Engr. Co.
Progressive Mfg. Co.
Rauch Nut & Mfg. Co., The
Raymond Machine Shop, Harold
Reliable Mach. Shop
Reliable Metal Novelty Co.
Reliable Spring & Wire Forms
Republic Steel Corp.
Reynolds Metals Co.
Rhode Island Tool Co.
Rochester Mach. Specialties
Rockford Screw Prods. Co.
Rodman & Co.
Rozum Motor Co.
Russell, Burdsall & Ward
Scarab Fastner Co.
Schuck Mfg. Co.
Shakeproof, Inc.
Schnitzer Alloy Products Co.
Scovill Mfg. Co.
Screw Machine Products Co., Inc.
Se-Ling Aircraft Co.
Seltzer & Co., Geo. H.
Shakeproof, Inc.
Shaw & Co.
Sherman Mfg. Co., H. B.
Simmonds Aerocessories, Inc.
Simmonds Machine Tool Corp.
Southington Hdwe. Mfg. Co., The
Speedometer Service & Accessories
Spool Cotton Co. Div.
Standard Pressed Steel Co.
Standardized Aircraft
Stanley Wks., The
Steel Forming Corp.
Stenger, Chas. V. & Sons
Strong, Carlisle & Hammond Co.
Swift Lubricator Co., Inc.
Talon, Inc.
Tex Machine Co.
Thompson Products, Inc.
Tinnerman Products, Inc.
Torrance Precision Mfg. Co.
Tourek Mfg. Co., J. J.
Tull Metal & Supply Co., J. M.
Transcontinental Machine & Tool
United Aircraft Parts Mfg. Co.
United-Carr Fastener Corp.
U. S. Pipe & Mfg. Co.
United Screw & Bolt Corp.
Universal Metal Prods.
Vide Products
Waldes Koh-I-Noor, Inc.
Walker & Co., Geo.
Waltham Screw Co.
Wayne Pump Co., The
Welded Aircraft Parts Co.
West. Aero Supply Mfg. Co.
Western Mfg. & Supply Co.
Whitehead Metal Prod. Co.
Whitehead Stamping Co.
Whitney Screw Corp.
Williams & Co., J. H.
Willis & Geiger, Inc.
Witek Mfg. Co.
Wolverine Bolt Co.
Worcester Stamped Metal Co.
Worcester Taper Pin Co.
Wrought Washer Mfg. Co.
Zephyr Mfg. Co.

31—FENCES

American Chain & Cable Co., Inc.
American Steel & Wire Co.
Anchor Post Fence Co.
Bethlehem Steel Co.
Borg Warner Corp.
Brown Fence & Wire Co., The
Columbia Steel Co.
Continental Steel Corp.
Cyclone Fence Div.
Eaton Metal Products Co.
Erie Concrete & Steel Supply Co.
Grossman Steel Stair Corp.
Metal Fabricators, Inc.
Page Fence Assn.



THE familiar adage concerning "no chain being stronger than its weakest link" may well apply to Cable Connectors used in the assembly and installation of Radio Communication Systems. It is important, therefore, to know that the precision and care exercised in the manufacturing of Coaxial Cable Connectors by The Astatic Corporation assure dependable service even under the most trying conditions. Approved by Army and Navy Engineers and highly praised and used by many leading manufacturers of electronic equipment, Astatic Connectors measure up to highest expectations in every way. Increased manufacturing facilities insure prompt shipments.

Approved Grip-to-Talk GDN Dynamic Microphone for airplane dispatching and factory paging system.

ASTATIC

IN CANADA: CANADIAN ASTATIC, LTD., TORONTO, ONTARIO

THE ASTATIC CORPORATION

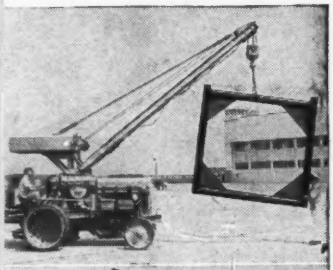
YOUNGSTOWN, OHIO

• Roustabout Cranes are hustling war materiel at home and overseas. (U. S. Signal Corps Photo).

MOVE IT FAST

Anywhere, Any Time with

Free-Roving Tractor-Footed ROUSTABOUT CRANES



THE big, bulky stuff you need to move, load, unload or stack—too heavy for men and outside the range of your installed handling equipment: Roustabout Crane handles it quickly, easily. It's *where* you want it, *when* you want it, day or night, prevents delays—tackles 6-ton loads without a whimper. Wheels or crawler tracks, all tractor power, ball-bearing boom turntable, gears in oil, full swing boom—built for years of overwork—a highly profitable investment in fast action around war-busy factories, airports, railroads, docks and warehouses. To keep things moving now, to cut post-war costs, write today for the complete Roustabout story.

Easy to operate, it's a whole crew of tireless roustabouts.

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637 Newman Street • Mansfield, Ohio

ROUSTABOUT CRANES
By Hughes-Keenan
Lead-Handling Specialists Since 1904

Pittsburgh Steel Co.
Voight & Son Co., R.

32—FINISHES & PROTECTIVE COATINGS

Abeles-Lewit Co., Inc.
Acme White Lead & Color Wks.
Aero Engineering, Inc.
Air Associates, Inc.
Air Transport Equip., Inc.
Air Transport Mfg. Co.
Aircraft Production Corp.
Aircraft Steel & Supply Co., The
Alox Corp.
Aluminum Co. of America
American Cellulose Co.
American Chemical Paint Co.
Antico Products Co., Inc.
Arco Co., The
Atlas Powder Co., Zapon Div.
Auld Co., The, D. L.

Baltimore Paint Color Wks., Inc.
Barrett Varnish Co.
Bell Co., Inc., The
Berry Bros.
Brooklyn Varnish Mfg. Co.
Brown Co., Andrew

Chicago Hardware Co., Inc.
Chicago Thrift Co.
Colonial Alloys Co.
Commercial Chemical Co.
Cook Paint & Varnish Co.
Cordo Chemical Corp.
Cowan Mfg. Co.

Dade Bros., Inc.
Daniels, Inc., C. R.
Detroit Rex Products Co.
Dibble Color Co.
Ditzler Color Div.
Du Pont de Nemours & Co., Inc. (Wilmington)
Driscoll & Co.
Durite Plastics, Inc.

Egyptian Lacquer Mfg. Co., The
Electro Chrome Co.

Ferdinand & Co., Inc., L. W.
Firestone Rubber & Latex
Fuller & Co., W. P. (San Francisco)
Fuller & Co., W. P. (L. A.)

Gem Shine Prods. Co.
General Finishes, Inc.
Glidden Co.
Goodrich Co., The, B. F.
Goodyear Tire & Rubber Co.
Grand Rapids Varnish Co.

Hayes Mfg. Corp.
Haynes Products Co.
Hilo Varnish Corp.
Hollingshead Corp., R. M.
Horn Co., A. C.
Houghton & Co., E. F.
Humble Oil & Refining Co.

Johnson & Son, Inc., S. C.
Jones-Dabney Co.

Kay & Ess., The
Kelite Prod., Inc.
Knape & Vogt Mfg. Co.
Koch Sons, Inc., George
Kuhns Paint & Varnish Works

Laucks, Inc., I. F.
Lehigh Chemical Products Co.
Lilly Varnish Co.
Los Angeles Heavy Hardware Co.
Los Angeles Plating Co.
Louisville Paint Mfg. Co.
Lowe Bros. Co., The

Mercury Chem. Co., Inc.
Metallizing Co. of America
Midland Paint & Varnish Co.
Miller Co., J. C.
Miro-Flex Co.
Monsanto Chemical Co.
Morris Paint & Varnish Co.
Munning & Munning, Inc.
Murphy Varnish Co.

National Lead Co.
National Radiator Co., The
Northern Engraving & Mfg. Co.

Pacific Chemical Co.
Paramount Rubber Co.
Parker Rust Proof Co.
Perry-Austen Mfg. Co.
Petroleum Marketing Co.
Pierce & Stevens, Inc.
Pitsburgh Plate Glass Co.
Pratt & Lambert, Inc.
Prods. Sales Corp.
Pyroxylin Products, Inc.

Quigley Co., Inc.

Randolph Finishing Products Co.
Reliance Varnish Co., Inc.
Reuther Equip. & Paint Co.
Reynolds Metals Co.
Reynolds-Robson Supply Co., The
Robertson Aircraft Corp.
Robinson Specialty Mfg. Co., Ltd.
Roxalin Flexible Finishes, Inc.

Schori Process Corp.
Sewall Paint & Varnish Co.
Sherwin-Williams Co.
Skylark Mfg. Co., Inc.
Socony Paint Products Co.
Sonneborn Sons, Inc., L.
Southern Cal. Plating Co.
Standard Varnish Works
Stegner, Chas. V. & Sons
Sterling Varnish Co., The
Stevens, Inc., Fred B.
Stoner-Mudge Co., Inc.
Success Plastics Recovery Wks.
Synvar Corp.

Testor Chem. Co.
Textileather Corp.
Thiokol Corp.
Thomson-Porcelite Paint Co.
Thresher Varnish Co., The
Titanine, Inc.
Turco Prods., Inc.

United Sanitary Chemicals Co.
United States Bronze Powder
United States Radium Corp.
U. S. Stoneware Co., The

Valentine & Co., Inc.
Vita-Var Corp.

Wailes-Dove-Hermiston Corp.
Washington Aircraft & Transport
Wayne Chem.-Prods. Co.
Wesley Lacquer Co.
Wiggins Airways, Inc., E. W.
Wilbur & Williams Co., The
Wipe-on Corp.
Worcester Stamped Metal Co.
Zapon Div. Atlas Powder Co.
Zophar Mills, Inc.

33—FIRE PROTECTION EQUIPMENT

Air Cruisers, Inc.
Akron Brass Mfg. Co., Inc.
American-LaFrance Foamite
Bean Mfg. Co., John
Bell Company, Inc., The
Buckeye Iron & Brass Works
Burcott Mills
C-O-Two Fire Equip.
Cardox Corp.
Carlinghouse Bros.
Chicago Metal Hose Corp.
Clancy, Inc., J. R.
Couch Co., Inc., S. H.
Daniels, Inc., C. R.
Dugas Engrg. Corp.
Elkardt Brass Mfg. Co., Inc.
Fire Equipment Co.
Fyr-Fyrter Co., The
Gamewell Co., The
General Detroit Corp., The
Grinnell Co., Inc.
Henkle & Joyce Hdwe. Co.
Hercules Equip. & Rubber Co.
Howe Fire Apparatus Co.
Hockaday & Phillips, Inc.
Industrial Supply Co., Inc.
Johns-Manville
Johnston & Jennings Co., The
Kelsey Hayes Wheel Co.
Kidde & Co., Inc., Walter
Marmon-Herrington Co., Inc.
Metal Products Engrg., Inc.
National Foam System, Inc.
Newman Mfg. Co., Ins.
Pacific Fire Extinguisher Co.
Phila. Asbestos Co.
Phister Mfg. Co.
Plymold Corp.
Pyrene Mfg. Co.
Q. R. S. Neon Corp., Ltd.
Reuther Equip. & Paint Co.
Rockwood Sprinkler Co.
Safety Fire Extinguisher Co., The
Smith & Co., D. B.
Snyder & Son, M. L.
Spencer Thermostat Co.
Standard Elec. Time Co., The
Sterling Siren Fire Alarm Co.
Thompson Glass & Paint Co.
Tull Metal & Supply Co., J. M.
U. S. Rubber Co.
Warden Appliance Co.
Welded Aircraft Parts Co.
White Motor Co.
Wil-X-Mfg. Corp.
Wooster Brass Co., The

34—FIRST AID EQUIPMENT

American Gauge Co., The
American-LaFrance-Foamite
Automatic Electrical Devices Co.
Bullard Co., E. D.
Burroughs Wellcome & Co., Inc.
Conray Products Co.
Davis Emergency Equip. Co., Inc.
First Aid Supply Co.
General Detroit Corp., The
Johnson & Johnson Co.
L. A. Rubber & Asbestos Works
Larrimore Sales Co.
Mine Safety Appliances Co.
ulmosan Safety Equipment Corp.
Scholl Mfg. Co., Inc., The
Seabury, Inc.
Thompson Glass & Paint Co.
Warden Appliance Co.
Wharry & Co., Inc., G. A.
Worcester Stamped Metal Co.

35—FLARES & SIGNALS

Aerial Products, Inc.
Aeronautical Trading Co.
Air Associates, Inc.
Aircraft Instrument Service, Inc.
American Cellulose Co.
Aviquipo, Inc.
Century Lighting, Inc.
Crouse-Hinds Co.
Dasco Products Co.
Duplan Corp.
Du Pont de Nemours & Co., Inc. E. I. (Wilmington)
Eclipse Pioneer Div.
Electronic Laboratories, Inc.
Eveready Hardware Mfg. Co., Inc.
Falge Engr. Services
General Detroit Corp., The
Henkle & Joyce Hdwe. Co.
International Flare Signal Div.
Kilgore Mfg. Co.
Liberty Display Fireworks Co.
McAleer Mfg. Co.
Miro-Flex Co.
New Jersey Fulgent Co.
Nichols & Cox Lumber Co.
Parachute Corp. of America, Inc.
Pioneer Instr. of Bendix Avia.
Reuther Equip. & Paint Co.
Security Parachute & Equipment
Speedometer Service & Accessories
Standard Molding Corp.
Strombeck-Becker Mfg. Co.
Tex Machine Co.
Triumph Explosives, Inc.
Young Spring & Wire Corp.

36—FLOATS & SKIS

Aero Trades Co.
Air Cruisers, Inc.
Air-Transport Equip., Inc.
Allied Aviation Corp.
American Aviation Corp.
Applegate Amphibians
Armstrong Cork Co.
Aviation Engineering, Inc.
B. H. Aircraft Co., Inc.
Bellanca Aircraft Corp.
Columbia Aircraft Industries
Edo Aircraft Corp.
Federal Aircraft Wks.
Federal Steel Corp.
Fletcher Aviation Corp.
Firestone Aircraft Co.
Gibson, Inc.
Goodyear Aircraft Corp.
Goodyear Tire & Rubber Co., Inc.
Heath Co.
Heintz Co., H. J.
Kilgen Aircraft Div.
Kirkham Engr. & Mfg. Corp.
Hardman Peck & Co.
Lester Industries, Inc.
Marine Air Research Corp.
Mercury Aircraft, Inc.
Pacific Fabricating Co.
Pulaski Veneer Corp.
Rheem Mfg. Co.
St. Louis Aircraft Corp.
Samson United Corp.
Thaden Engineering Co.
Troyer Aircraft
Union Oil Co. of Cal.
West Branch Novelty Co.
White Aircraft Corp.
Wiggins Airways, Inc., E. W.

37—FORGINGS

Accessory Forgings Co.
Aerial Mach. & Tool Corp.
Aero Bolt & Screw Co.
Airchox Co., Div.
Aircraft Mechanics, Inc.
Aircraft Steel & Supply Co., The
Allegheny Ludlum Steel Corp.
Alliance Drop Forging Co., The
Altens Fdry & Mach. Wks.
Aluminum Co. of America
American Art Alloys, Inc.
American Brass Co., The
American Chain & Cable Co.
American Manganese Bronze Co.
American Screw Products
Atlas Drop Forge Co.
Auld Co., The, D. L.
Baldt Anchor, Chain & Forge Co.
Barcalo Mfg. Co.
Bethlehem Steel Co.
Billings & Spencer Co., The
Bohn Aluminum & Brass Co.
Bonney Forge & Tool Wks.
Brill Co., The J. G.
Cahil Forge & Fdry Co.
Cal-Air-Prod Co.
Camden Forge Co.
Canton Drop Forging & Mfg. Co.
Champion Mach. & Forging Co.
Clapp Mfg. Co., The, E. D.
Cleveland Pneumatic Tool Co.
Dockson Corp.
Dow Chemical Co.
Dresser Mfg. Co.
Drop Dies & Forgings Co., The
E F G Enginering Works, Inc.
Endicott Forging & Mfg. Co.
Gardner-Denver Co.
General Drop Forge, Div.
General Metals Corp.
Globe Forge & Foundries Co.
Harrisburg Steel Corp.
Hayes Mfg. Corp.
Heppenstall Co.
Herbrand Corporation, The
Highbridge International Co.
Hurley & Sons, Inc., D.
Indianapolis Drop Forging Co.
Interstate Drop Forge Co.
Iron City Tool Works
Johnson & Jennings Co., The
Kohler Co.
Kraeuter & Co., Inc.
Kropp Forge Co.
Ladish Drop Forge Co.
Larson & Sons, Inc., Charles E.
Laughlin Co., The, Thomas
Letts Drop Forge, Inc.
Magnesium Prods., Inc.
Michigan Forging Co.
Mondie Forge Co., Inc.
Moore Drop Forging Co.
Mueller Brass Co.
Omaha Steel Works
Pacific Car & Foundry Co.
Park Drop Forge Co., The
Paulson Tools, Inc., The
Phoenix Mfg. Co.
Products Engrg. Co.
Reliable Metal Novelty Co.
Revere Copper & Brass, Inc.
Reynolds Metals Co.
Rhode Island Tool Co.
St. Pierre Chain Corp.
Sandsea Co., Harry
Spalding & Bros., A. G.
Speedometer Service & Accessories
Steel Improvement & Forge Co.
Storms Drop Forging Co.
Tex Machine Co.
Transue & Williams Steel Forg.
Union Drawn Steel Div.
Union Fork & Hoe Co., The
Unit Drop Forge
United States Spring & Bumper
U. S. Pipe & Mfg. Co.
Warren Tool Corp.
Weatherhead Co., The
Welded Aircraft Parts Co.
Western Forge & Tool Wks.
Williams & Co., J. H.
Wyman-Gordon Co.

38—FUELS

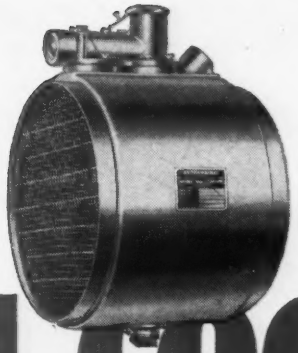
Atlantic Refining Co.
Carson, Marshal & Co., Inc.
Cities Service Oil Co.
Ethyl Corp.
General Petroleum Corp.
Gulf Oil Corp. (Aviation Dept.)
Harman Equipment Co.
Humble Oil & Refining Co.
Keystone Lubricating Company
Mid-Continent Petroleum Corp.
Pennsylvania Grade Crude Oil
Pennzoil Co., The
Phillips Petroleum Co.
Pure Oil Co., The
Ritter Lumber Co., W. M.
Shell Oil Co.
Sinclair Refining Co.
Socony-Vacuum Oil Co., Inc.
Standard Oil Co.
Standard Oil Co. of N. J.
Texas Co., The
Union Oil of Calif.
U. S. Industrial Chemicals
Wasatch Oil Refining Co.
Wolf's Head Oil Refining Co.
Wolverine-Empire Refining Co.

39—FUEL SYSTEMS—AIRPORT

Acme Pump & Tank Corp.
Aqua Systems, Inc.
Bowser, Inc.
Buckeye Iron & Brass Works
Columbian Steel Tank Co.
Dasco Products Co.
Eaton Metals Products Co.
Erie Meter Systems, Inc. (Okla.)
Fairbanks, Morse & Co.
Flotation Systems, Inc.
Gilbert & Barker Mfg. Co.
Goulds Pumps, Inc.
Granberg Equipment, Inc.
Harman Equipment Co.
Hilliard Corp., The
Hockaday & Phillips, Inc.
Independent Iron Wks., Ltd.
Lights, Inc.
Martin & Schwartz, Inc.
Metal Hose & Tubing Co.
Ohio Pattern Wks. & Foundry
Peerless of America, Inc.
Philia. Valve Co.
Photoswitch, Inc.
Pittsburgh-Des Moines Steel Co.
Reuther Equip. & Paint Co.
Roper Corp., Geo. D.
Rusgreen Mfg. Co.
Shields, Harper & Co.
U. S. Flexible Metallic Tubing
Warner Lewis Co.
Wayne Pump Co., The

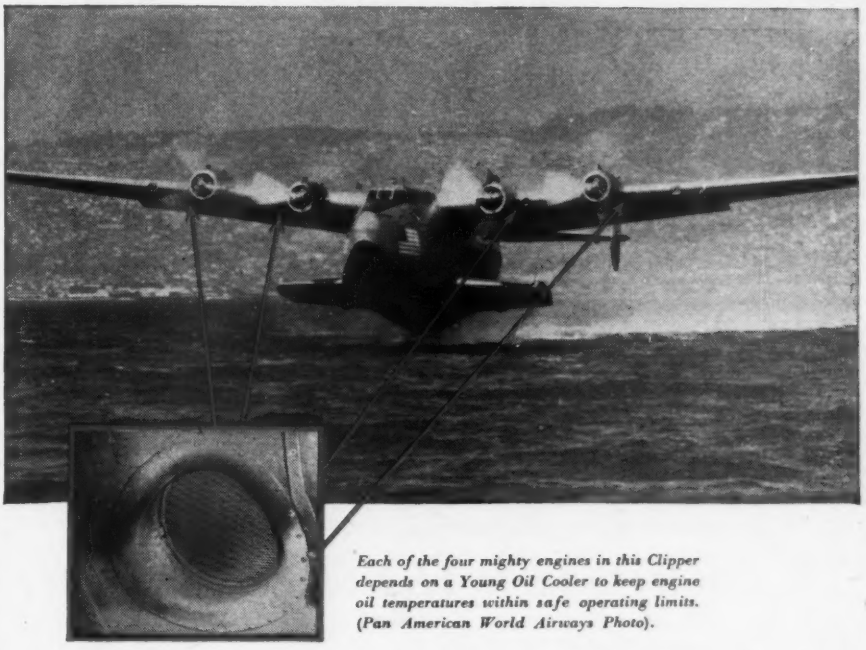
40—FUEL PUMPS & SYSTEMS —AIRCRAFT

A & F Aluminum Prods. Co.
Adel Precision Products Corp.
Aerc Supply Mfg. Co., Inc.
Aeronautical Mfg. Corp.
Air Associates, Inc.
Aircraft Instrument Service, Inc.
Aircraft Products Co.
Aircraft Steel & Supply Co., The
American Bosch Corp.
American Flange & Mfg. Co., Inc.
American Pioneer Div.
Aro Equipment Corp.
Barnes Corp., John S.
Bendix Products Div.
Blackmer Pump Co.
Borg-Warner Corp.
Breeze Corps. Inc.
Briggs Clarifier Co.
Candler-Hill Corp.
Century Aircraft Co.
Chamberlin Metal Weatherstrip
Chandler-Evans Corp.
Chicago Metal Hose Corp.
Clarke Aero-Hydraulics, Inc.
Cleveland Aircraft Products Co.
Columbia Aircraft Industries
Cuno Engr. Corp.
Curtis Pump Co.
Denison Engineering Co.
Dollinger Corp.
Eastern Engr. Co.
Eaton Mfg. Co.
Erie Meter Systems, Inc. (Okla.)
Fernholtz Machinery Co.
Fuel Injection Corp.
Granberg Equipment, Inc.
Henkle & Joyce Hdwe. Co.
Hilliard Corp., The
Hydropack
Ingersoll-Rand Co.
Jones Motrola Sales Co.
Kenyon Instrument Co., Inc.
Lane-Wells Co.
Lear Avia, Inc.
Lights, Inc.
Liss Aircraft Prods. Co.
Logan & Whittington Co.
McInerney Plastics Co.
Martin & Schwartz, Inc.
Nash Engrg. Co.
Oberdorfer Brass Co., M. L.
Peerless Mach. Co.
Persons Corp., L. M.
Pesco Prod. Co.
Protectoseal Co.
Purolator Prod., Inc.
Racine Tool & Mach. Co.
Ripley Mfg. Co.
Rochester Mfg. Co.
Rohlm Mfg. Co., Inc.
Romec Pump Co.
Roper Corp., Geo. D.
Shields, Harper & Co.
Skinner Purifiers, Inc.
Sparkler Mfg. Co.
Speedometer Service & Accessories
Stewart Warner Corp.



ANOTHER EXAMPLE OF **YOUNG** AVIATION SERVICE

OIL COOLERS for CLIPPERS



Each of the four mighty engines in this Clipper depends on a Young Oil Cooler to keep engine oil temperatures within safe operating limits. (Pan American World Airways Photo).

Young is proud to have had a part in spanning the skyways of the world. Experience that began thirty years ago made it possible for Young Heat Transfer Products to contribute to the amazing development of commercial aviation, climaxed by giant Clipper ships encircling the globe. When war broke out Young engineers were ready! They produced equipment that could stand the punishment of fast flying, long trips, furious fighting. They did more . . . they developed automatic accessories and controls to regulate temperature and flow of coolants for quick take-offs, power dives and steep climbs, thus freeing pilots and crews for concentration on combat. And now, though still deep in war work, Young engineers are finding time to put thought on the heat transfer problems of the postwar world. Consult with them, without obligation.

YOUNG RADIATOR CO., Dept. , Racine, Wis., U.S.A.

Distributors: Pacific Airmotive, Burbank, Cal. Aircraft Steel & Supply Co., Wichita, Kansas

YOUNG

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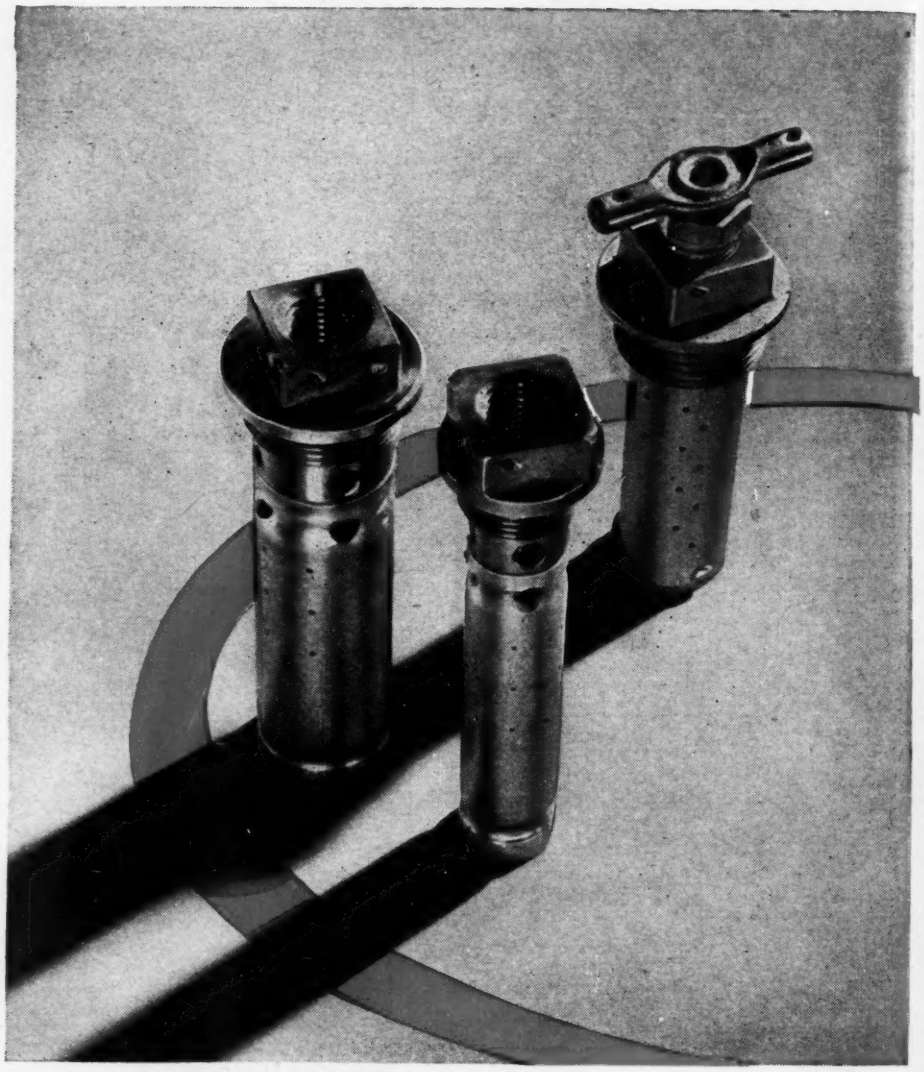
HEAT TRANSFER PRODUCTS

Oil Coolers • Gas, Gasoline, Diesel Engine Cooling Radiators • Intercoolers • Heat Exchangers • Engine Jacket Water Coolers • Unit Heaters • Convectors • Condensers • Evaporators • Air Conditioning Units • Heating Coils • Cooling Coils • and a Complete Line of Aircraft Heat Transfer Equipment.



Corrosion Inhibitor Cartridge Assemblies

Among the many types of aircraft parts and accessories that Air Associates is producing and supplying in large quantities is a complete line of quality-made Corrosion Inhibitor Drain Cartridges and Assemblies . . . Included are—the standard AN4043-2 Cartridge Assembly, the AAF37B4095-1 and AAF37B4095-2 Cartridge Assemblies, also other NAF types. Where required, special models will be furnished to customers' drawings . . . All Air Associates Cartridges and Assemblies are manufactured in strict accordance with applicable AN, AAF or NAF drawings and specifications. *Whether your needs be large or small, remember Air Associates is a dependable source of supply.*

Air Associates, Inc.

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Stow Mfg. Co., Inc.
Thompson Prod., Inc.
United Aircraft Products, Inc.
Wire Cloth Prods., Inc.

41—GASKETS & SEALING DEVICES

Ace Gasket Co.
Acme White Lead & Color Wks.
Adel Precision Products Corp.
Aero Supply Mfg. Co., Inc.
Aeronautical Trading Co.
Air-Parts, Inc.
Alpha Metal & Rolling Mills,
American Felt Co.
Armstrong Cork Co.
Atlantic India Rubber Works
B G Corp., The
Backstay Welt Co.
Belco Industries, Inc.
Bell Company, Inc., The
Bowling Green Rubber Co.
Bridgeport Fabrics, Inc.
Buffalo Weaving & Belting Co.
Burlington Mills, Inc.
Chanslor & Lyon Co.
Chardon Rubber Co., The
Chicago-Wilcox Mfg. Co.
Chicago Cork Works Co.
Chryson's Ltd.
Clarke Aero-Hydraulics, Inc.
Conn. Hard Rubber Co.
Continental Rubber Wks.
Crane Packing Co.
Cunningham Hall Aircraft Corp.
Davton Rubber Mfg. Co., The
Detroit Gasket & Mfg. Co.
Dodge Cork Co., Inc.
Dunne Rubber Co.
Elmhurst Rubber Co., Inc.
Emsco Asbestos Co.
Everseal Products
Excelsior Leather Washer Mfg.
Felt Products Mfg. Co.
Ferdinand & Co., Inc., L. W.
Firestone Aircraft Co.
Firestone Rubber & Latex
Fitzgerald Mfg. Co., The
Gardner Co., J. R.
Garlock Packing Co., The
Gasket Shop
Gates Rubber Co.
Gatke Corp.
Gemloid Corp.
Golden State Rubber Mills
Goodall Rubber Co.
Goodrich Co., The, B. F.
Goodyear Tire & Rubber Co., Inc.
Goshen Rubber Mfg. Co.
Graton & Knight Co.
Hercules Equip. & Rubber Co.
Holfast Rubber Co., The
Hollingshead Corp., R. M.
Houghton & Co., E. F.
Hunter Sash Co., Inc.
Hydropack
Ideal Roller & Mfg. Co.
Industrial Prods. Suppliers
Industrial Supply Co., Inc.
Industrial Tool & Die Wks, Inc.
Johns-Manville
Kirby Co., The
Koppers Co.
L. A. Rubber & Asbestos Works
LaSalle Furniture Co.
Linear Packing & Rubber Co.
Lowry Electrical Co., Inc.
McCord Radiator & Mfg. Co.
McInerney Plastics Co.
Manhattan Rubber Mfg. Div.
Martin Rubber Co., Inc.
Metallo Gasket Co.
Miller Products Co., Inc.
Minnesota Mining & Mfg. Co.
Moss & Co., Henry
National Motor Bearing Co., Inc.
New England Tape Co., Inc.
Ohio Rubber Co.
Paul & Beekman Div.
Philadelphia Asbestos Co.
Pittsburgh Plate Glass Co.
Plastic Prod. Co.
Plastic & Rubber Products Co.
Precision Fabricators, Inc.
Prestite Engr. Co.
Prince Rubber Co., Inc.
Quaker Rubber Corp.
Radiator Specialty Co.
Raybestos Manhattan, Inc.
Rhodes & Co., James H.
Rubbercraft Corp. of Cal.
Seiberling Rubber Co., Inc.
Southern Friction Materials Co.
Sponge Rubber Products Co.
Standard Products Co., The
Standard Rubber Co.
Stone, Harry E. Rubber Co.
Stritt & Priebe, Inc.
Success Plastics Recovery Wks.,
Trippe Mfg. Co.
Twin City Tool Co.
Tyer Rubber Co.
United Oil Mfg. Co.
U. S. Rubber Co.
U. S. Stoneware Co., The
Universal Engrg. Co.
Van Cleef Bros.
Vellumoid Co., The
Victor Mfg. & Gasket Co.
Virginia Rubatex Div.
Voit Rubber Co.
Vulcan Proofing Co.
West American Rubber Co.
Westinghouse Air Brake Co.
Wharry & Co., Inc., G. A.
Wilmington Fibre Spec. Co.
Wolverine Fabricating & Mfg.
Worcester Stamped Metal Co.
Zophar Mills, Inc.

42—GEARS

Aircraft Mechanics, Inc.
American Radio Hardware Co.
Ampco Metal, Inc.
Andrews Hardware & Metal Co.
Automotive Gear Wks., Inc.
Barcus Engr. Co.
Borg Warner Corp.
Boston Gear Works, Inc.
Bridgeport Worm & Gear Mfg.
Christiana Machine Co.
Cleveland Worm & Gear Co., The
Columbia Aircraft Products, Inc.
Detroit Gear
Detroit Harvester Co.
Diefendorf Gear Corp.
Dockson Corp.
Drexler Co., Chas.
Eaton Mfg. Co.
Fairfield Mfg. Co.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Mach. Corp.
Formica Insulation Co., The
Franklin Fibre-Lamitex Corp.
Gear Co., L. M.
Gear Grinding Mach. Co., The
Gear Specialties
General Electric Co.
Hartford Special Machy. Co.
Illinois Gear & Mach. Co.
Indiana Gear Wks.
Industrial Gear Mfg. Co.
Industrial Tool & Die Wks., Inc.
Josephson & Sharp Mfg. Co.
L. A. Automotive Wks.
L & W Parts Co
Levene Motor Co.
Livingston Machine Shop
McInerney Plastics Co.
Martin & Schwartz, Inc.
Meisel Press Mfg. Co.
Memphis War Industries, Inc.
Miller Knuth Mfg. Co.
Panelyte Div.
Peerless Mach. Co.
Plastic Prod. Co.
Production Tooling Co.
Reliable Mach. Shop
Rozum Motor Co.
Stewart Warner Corp.
Taft Peirce Mfg. Co.
Taylor Fibre Co.
Taylor Machine Co., The
Timken Detroit Axle Co., The
United Aircraft Prods., Inc.
Universal Gear Corp.
Warner Gear Div. Borg-Warner
Western Gear Works
Western Mfg. Co.
Whaley Engineering Corp.
Wheeler Mfg. Co., C. H.
Whitney Chain & Mfg. Co.
York Shipley, Inc.

43—GLASS

American Window Glass Co.
Bache & Co., Semon
Carter-Lockard Co.
Corning Glass Works
Dockson Corp.
Dunbar Glass Corp.
Fuller & Co., W. P. (San Francisco)
Hammel, Riglander & Co., Inc.
Howell, Sherburne & Co.
Libbey-Owens-Ford Glass Co.
Perkin-Elmer Corp.
Pittsburgh Plate Glass Co.
Protecto Safety Glass Co.
Safetee Glass Co.
Speedometer Service & Accessories
Spencer Heater Div.
Stott Hecht Glass Works
Thompson Glass & Paint Co.

43(a)—HEAT TREATING

Aerocraft Heat Treating Co.
Aircraft Bolt & Rivet Co.
Ajax Electric Co., Inc.
Abegg & Reinhold Co., Ltd.
B-M Heat Treating Co.
Bennett Metal Treating Co.
Boose Aluminum Fdry
Chicago Hardware Foundry Co.
Commercial Heat Treating Co.
Commonwealth Industries, Inc.
Continental Indus. Engrs.
Cook Heating Treating Corp.
Drever Co., The
Durlron Co., Inc., The
Light Alloys Mfg. Co., The
Metallergical Laboratories, Inc.
Ohio Crankshaft, Inc.
Rozum Motor Co.
Twiss Heat Treating Co.
Trent Co., Harold E.
Westinghouse Elec. & Mfg. (Pittsburgh)
White Heat Treating Co.

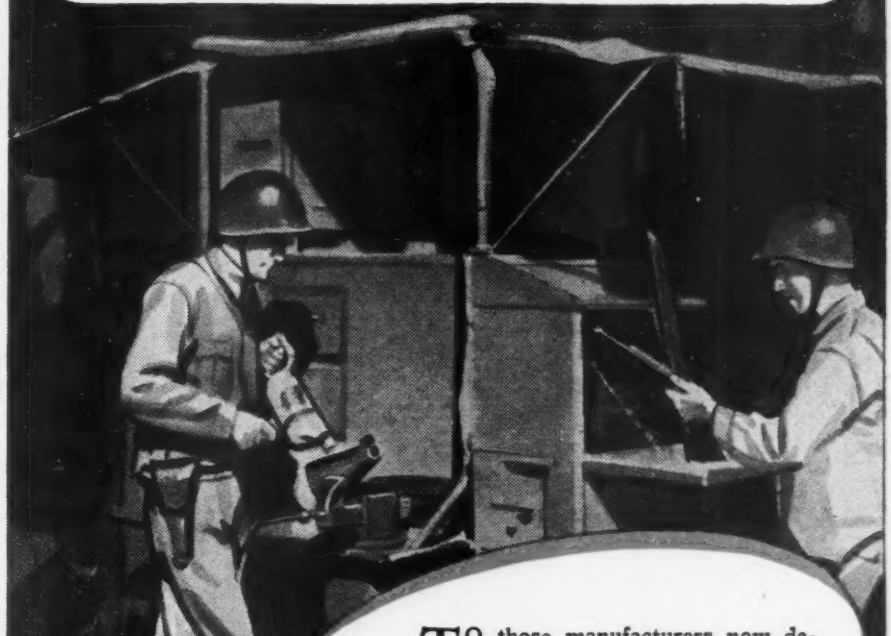
44—HEATERS

Abrams Instrument Corp.
Aero Engineering, Inc.
Aircraft Specialties Co.
Airesearch Mfg. Co.
American Foundry & Furnace Co.
American Fdry. Equip. Co.
American Instrument Co.
Anchor Post Fence Co.
Avia Products Co.
Borg Warner Corp.
Cahill Forge & Fdry.
Chicago Hardware Foundry Co.
Cities Service Oil Co.
Cole Electric Co.
Cutler-Hammer, Inc.
Dravo Corp.
Drayer & Hanson, Inc.
Du Pont de Nemours & Co., Inc., E. I. (Wilmington)
E. A. Laboratories, Inc.
Eaton Mfg. Co.
Electric Air Heater Co. Div.
Fedders Mfg. Inc.
Fulton Co., The
Garrett Corp., The
General Electric Co.
Hanlon & Wilson Co.
Henkle & Joyce Hdwe. Co.
Herman Nelson Corp., The
Hunter & Co.
Ilg Electric Ventilating Co.
Lear Avia, Inc.

A Mobile Service...

FOR ANY GUN — PISTOL TO HOWITZER

"Keep 'em Firing"—no matter where they are. That's the slogan. Repair crews, with their mobile workshops, service all types of guns, from pistols to howitzers. Generating units, powered by gasoline engines, charge batteries and operate electric drills and other modern tools. This is typical of the multitude of vital jobs — both standard and special — for hundreds of thousands of rugged, dependable Briggs & Stratton engines "in the service."



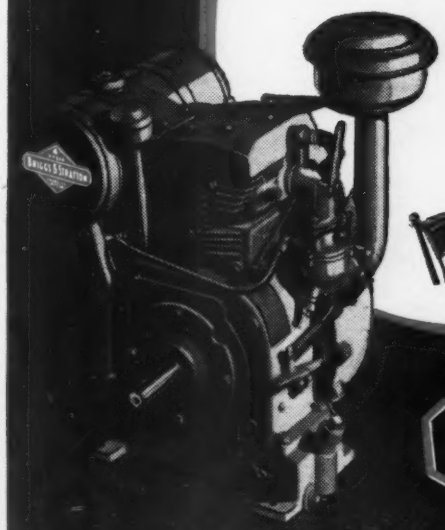
TO those manufacturers now designing and experimenting with machines, tools, or equipment to be powered by portable gasoline engines, we offer the services and long experience of Briggs & Stratton's engineering and development staffs, without any expense or any obligation.

Their assistance and counsel may save you weeks of time and many headaches, and effect material economies and greater efficiency.

The reputation of Briggs & Stratton is world wide in the gasoline engine field. Thousands of dealers and millions of owners and users know that—

"It's powered right — when it's powered by Briggs & Stratton."

BRIGGS & STRATTON CORP.
MILWAUKEE 1, WIS., U. S. A.



BACK THE ATTACK WITH MORE WAR BONDS

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

Lowry Electrical Co., Inc.
McQuay, Inc.
MacLeod Co.
Menasco Mfg. Co.
Molded Insulation Co.
Monmouth Engr. Co.
Peerless of America, Inc.
Pollak Mfg. Co.
Reynolds Molded Plastics, Div.
Reznor Mfg. Co.
Rome-Turney Radiator Co.
Ross Heater & Mfg. Co., Inc.
Selas Co., The
Skylark Mfg. Co., Inc.
Spencer Heater Div.
Stewart Warner Corp.
Sturtevant Co., B. F.
Surface Combustion Co.
Thermador Elec. Mfg. Co.
Tenney Engrg. Inc.
Torrington Mfg. Co., The
Trane Co.
Trent Co., Harold E.
Tropic-Aire Co.
U. S. Fire Protection Co.
Utility Metal Prods. Co.
Warren Engrg. Co., Inc.
Watlow Mfg. Co.
Westinghouse Elect. & Mfg. Co.
Wiegand Co., Edwin L.
Wing Mfg. Co., L. J.
York-Shipley, Inc.
Young Radiator Co.

45—HOISTS, CRANES, JACKS, LIFTS, ETC.

Abell-Howe Co.
Aeronautical Machy Corp.
Airplane Mfg. & Supply Corp.
Almquist Bros. & Viets
Altens Fdry. & Machy. Wks.
American Chain & Cable Co.,
American Engineering Co.
American MonoRail Co.
Apex Steel Corp., Ltd.
Aviation Engineering, Inc.
Barrett-Cravens Co.
Bay City Shovels, Inc.
Beebe Bros.
Blackhawk Mfg. Co.
Blum & Co., Inc., Julius
Bridgeport Chain & Mfg. Co.
Busser Supply Co.
Chisholm-Moore Hoist Corp.
Cleveland Tramrail Div.
Clyde Iron Works, Inc.
Coffing Hoist Co.
Conco Engineering Works
Curtis Mfg. Co.
Curtis Pneumatic Machy. Div.,
Davenport Mfg. Co.
Del-Air Corp.
Detroit Hoist & Machine Co.
Duff-Norton Mfg. Co.
Eclipse Pioneer Div.
Elevator Engineering Co.
Erie Steel Constr. Co.
Ernst, Inc., Chas. R.
Federal Aircraft Wks.
Food Machy. Corp.
G.A.C. Mfg. Co.
Gardner-Denver Co.
Garlinghouse Bros.
Globe Hoist Co.
'HH' Mfgs.
Hanson Clutch & Machy. Co.
Harnischfeger Corp.
Heil Co., The
Heppenstall Co.
Hobbs Co., Clinton E.
Hockaday & Phillips, Inc.
Hufford Mach. Wks., Inc.
Hughes-Keenan Co., The
Independent Iron Wks., Ltd.
Industrial Supply Co., Inc.
Ingersoll-Rand Co.
Irvington Steel & Iron Wks.
Independent Pneumatic Tool Co.
Judson-Pacific Company
Kinmont Mfg. Co.
Kuhlman Elec. Co.
Lewis-Shepard Prods., Inc.
Louden Machy. Co.
Lowry Electrical Co., Inc.
Lyon-Raymond Corp.
Malabar Machine Co.
Mathews Conveyor Co.
Mechanical Handling Systems
Michigan Engine Valve Co.
Miller Co., J. C.
Neal & Brinker Co.
O. K. Clutch & Machinery Co.
Ornitz & Co., Edward M.
Pacific Car & Foundry Co.
Pacific Railway Equip. Co.
Peerless Mach. Co.
Phillips Pump & Tank Co.
Reading Chain & Block Corp.
Reuther Equip. & Paint Co.
Revolvator Co.
Richards-Wilcox Mfg. Co.
Richter Engrg. Co.
Rotory Lift Co.
Round & Son, David
Safway Steel Products, Inc.
Scott Aviation Corp.
Schwitzer-Cummins Co.
Sedgwick Mach. Wks.
Service Caster & Truck Div.
Shepard Niles Crane & Hoist
Silent Hoist Winch & Crane Co.
Smith-Courtney Co.
Spencer & Morris
Spillman Engineering Corp.
Sprout Waldron & Co.
Stephens-Adamson Mfg. Co.
Stow Mfg. Co., Inc.
Sullivan Machinery Co.
Taylor Machine Co., The
Templeton, Kenly & Co.
Tull Metal & Supply Co.
Tyler Fixture Corp.
Union Mfg. Co.
U. S. Air Compressor Co.
U. S. Pipe & Mfg. Co.
U. S. Steel Supply Co.
Walker Mfg. Co. of Wis.
Wash. Iron Wks.
Watson-Stillman Co.
Wellman Engineering Co., The
West Bend Equip. Corp.
Western Gear Wks.
Whaley Engineering Corp.
Wheeler Mfg. Co., C. H.
White Motor Co.
Whiting Corp.
Willamette-Hyster Co.
Williamsville Bus Mfg. Co.
Wolfe & Mann Mfg. Co.
Wright Mfg. Div.

46—HOSE—METAL

Air-Parts, Inc.
American Brass Co., The
Bendix Aviation Corp.
Breeze Corp., Inc.
Butler Mfg. Co.
Chicago Metal Hose Corp.
Everhot Products Co.
Industrial Supply Co., Inc.
International Metal Hose Co.
L. A. Rubber & Abestos Works
Packless Metal Prods. Corp.
Pennsylvania Flexible Metallic
Peterson, F., Somers, Co.
Reuther Equip. & Paint Co.
Seamlex Co., Inc.
Searle Aero Industries, Inc.
Shields, Harper & Co.
Smith-Courtney Co.
Titeflex, Inc.
Tull Metal & Supply Co., J. M.
U. S. Flexible Metallic Tubing

47—HOSE—RUBBER & SYNTHETIC

Aeronautical Trading Co.
Aeroquip Corp.
Air Cruisers, Inc.
Aircraft Steel & Supply Co., The
Air-Parts, Inc.
Anchor Plastics Co.
Bethlehem Equip. Corp., Ltd.
Bowling Green Rubber Co.
Buffalo Weaving & Belting Co.
Butler Mfg. Co.
Canfield Co., The H. O.
Carbide & Carbon Chem. Corp.
Chamberlain Co.
Chardon Rubber Co., The
Cleveland Pneumatic Tool Co.
Continental Rubber Wks.
DeVilbiss Co., The
Dockson Corp.
Dunne Rubber Co.
du Pont de Nemours & Co., Inc., E. I. (Wilmington)
Elkhart Brass Mfg. Co.
Erie Concrete & Steel Supply Co.
Erie Resistor Corp.
Everhot Products Co.
Extruded Plastics, Inc.
Fire Equipment Co.
Firestone Aircraft Co.
Firestone Rubber & Latex Prods.
Flex-O-Tube Co.
Gasket Shop, The,—Div. of Her-Gates Rubber Co.
Gemloid Corp.
General Electric Co.
General Tire & Rubber Co., The
Gilbert & Barker Mfg. Co.
Goodall Rubber Co.
Goodrich Co., The B. F.
Goodyear Tire & Rubber Co., Inc.
Henkle & Joyce Hdw. Co.
Hercules Equip. & Rubber Co.
Hewitt Rubber Corp.
Hockaday & Phillips, Inc.
Holfast Rubber Co., The
Independent Pneumatic Tool Co.
Industrial Supply Co., Inc.
Industrial Synthetics Corp.
Johnson Rubber Co., The
L. A. Rubber & Abestos Works
Lowry Electrical Co., Inc.
McInerney Plastics Co.
Manhattan Rubber Mfg. Div.
Metal Hose & Tubing Co.
Miller Co., J. C.
Miller Products Co., Inc.
Monarch Rubber Co., The
Neal Co., Inc., R. C.
New England Tape Co., Inc.
Peterson, F. Somers Co.
Philpott Rubber Co., The
Pioneer Rubber Mills
Prince Rubber Co., Inc.
Quaker Rubber Corp.
Raybestos-Manhatan, Inc.
Republic Rubber Div.
Resistoflex Corp.
Reuther Equip. & Paint Co.
Robbins Co., J. R.
Rodie Rubber Corp.
Schaeffer, Albert
Shields, Harper & Co.
Smith-Courtney Co.
Snyder & Son, M. L.
Stone, Harry E. Rubber Co.
Sullivan Machinery Co.
Swan Eng. Co., Inc.
Thermoid Co.
Tull Metal & Supply Co., J. M.
Tyer Rubber Co.
U. S. Flexible Metallic Tubing
U. S. Rubber Co.
U. S. Steel Supply Co.
U. S. Stoneware Co., The
Weatherhead Co., The
Welded Aircraft Parts Co.
West American Rubber Co.
Wharry & Co., Inc., G. A.

48—HYDRAULIC SYSTEMS

A & F Aluminum Prods. Co.
Adel Precision Products Corp.
Aero-Coupling Corp.
Aero Supplies
Aeronautical Mfg. Corp.
Aeroquip Corp.
Air Associates, Inc.
Aircraft Accessories Corp. (Cal.)
Aircraft Engrg. Products, Inc.
Aircraft Industries Corp.
Aircraft Parts Production Corp.
Aircraft Products Co.
Aircraft Welded Clamp Co.
Airex Mfg. Co.
Alco Valve Co.
All American Aircraft Products
American Fitting Co.
American Screw Products
American Thermometer Co.
Aqua Systems, Inc.
Aro Equipment Corp.
Aviation Parts, Inc.
Bardwell & McAlister
Barnes Corp., John S.
Ben Mfg. Co., The
Bendix Aviation, Ltd.
Bendix Products Div.
Bird Aircraft Products
Bobrick Mfg. Corp.
Bokum Tool Co.
Booth Mfg. Co.
Borg Warner Corp.
Brady Conveyors Corp., The
Caine Steel Co.
Cash Co., A. W.
Chicago Metal Hose Corp.
Chicago Pneumatic Tool Co. (Garfield)
Clarke Aero-Hydraulics, Inc.
Columbia Aircraft Industries
Cosco Mfg. Co.
Diamond Iron Works, Inc.
Dole Valve Co., The
Domestic Mfg. Co.
Eclipse Pioneer Div.
Edwards Co.
Electric Sprayit Co., The
Electrol, Inc.
Engineering Development Assoc.
Federal Aircraft Wks.
Firestone Aircraft Co.
Fleetwings Div. Kaiser Cargo
Food Machy. Corp.
Frigidaire Div.
Fuel Development Corp.
Gabriel Co., The
General Electric Co.
Gerotor May Div.
Gilfillan Bros., Inc.
Gladden Prods. Div.
Greer Hydraulics
Hagedorn Engrg.
Harvill Corp., The
Hawks Co., R. A.
Hoof Prods. Co.
Houde Engrg. Div.
Hub Industries, Inc.
Hydraulic Equip. Co.
Hydropack
Hydro-Power Systems, Inc.
Ideal Roller & Mfg. Co.
International Metal Hose Co.
Interstate Aircraft & Engrg. Corp.
Jack & Heintz, Inc.
Joyce-Cridland Co., The
Kenyon Instrument Co.
Kinmont Mfg. Co.
Liberty Aircraft Products Corp.
Liberty Motors & Engrg. Corp.
Linear Packing & Rubber Co.
Link-Belt Speeder Corp.
Liss Aircraft Prods. Co.
Marine Products Div.
Master, Inc., Irvin W.
Maytag Co., The
Monroe Auto Equipment Co.
National Pneumatic Co.
Neal Co., Inc., R. C.
New York Air Brake Co., The
Pacific Airmax Corp.
Pacific Aviation Inc.
Peerless Mach. Co.
Pesco Prod. Co.
Phillips Aviation Co.
Plastic Prod. Co.
Reasor Mfg. Co.
Reda Mfg. Co.
Robins Co., J. R.
Rochester Mfg. Co.
Rodman & Co.
Root Co., B. M.
Simmonds Aerocessories, Inc.
Simmons Mfg. Co.
Sorensen & Co., Inc.
Southern Cal. Plating Co.
Sperry Products, Inc.
Starbird, Geo. A.
Stow Mfg. Co., Inc.
Studebaker Mach. Co.
Swan Eng. Co., Inc.
Swift Lubricator Co., Inc.
Tycoon Tackle, Inc.
Uebelhoer Bros., Inc.
United Aircraft Products, Inc.
U. S. Pipe & Mfg. Co.
Universal Engrg. Corp.
Vard, Inc.
Vickers, Inc.
Wagner Elec. Corp.
Watson-Stillman Co.
Weatherhead Co., The
Wells Aircraft Parts Co.
Western Gear Works
Western Mfg. Supply Co.
Westinghouse Air Brake Co.

49—IGNITION EQUIPMENT

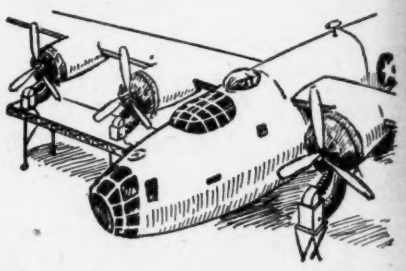
AC Spark Plug Div.
Air Associates, Inc.
Aircraft Instrument Service, Inc.
Air Shields, Inc.
Air-Parts, Inc.
American Bosch Corp.

HUNTER DEVELOPS SIMPLE GASOLINE UNIT PREHEATER

One-to-an-Engine Method Has Advantages of Flexibility And Fuel Economy

EASY TO HOOK UP—TAKE DOWN

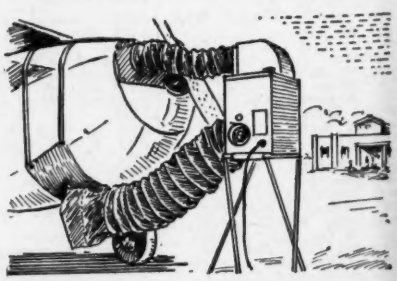
CLEVELAND, OHIO—The problem of pre-heating aircraft engines in severe weather has been simplified by the new gasoline burning preheaters recently announced by Hunter and Company of this city. The Hunter units are light and



compact, can be easily handled by one man, are used one unit to an engine, deliver a blast of hot air directly over all working parts.

The Hunter units can be used economically for either single or multiple engine planes. Each unit, weighing but 47 pounds, delivers up to 25,000 B.t.u. per hour, recirculating heated air in an engine housing through the close-coupled flexible duct system which assures useful delivery of a maximum proportion of heat. This makes it possible to pump hot air over a cold engine in sufficient volume to bring it to easy starting temperature in a matter of minutes, even in severe weather.

Ducts attach to the breather openings of an engine cowl of a small plane, as illustrated below, or to special airtight engine covers provided for radial installations, above. Rapid heating and recirculation of air within the enclosed area results in even heating of all working engine parts. Oil sump, cylinders and valves can be readied as well as carburetion and ignition system, thus preventing the too-well-known dam-

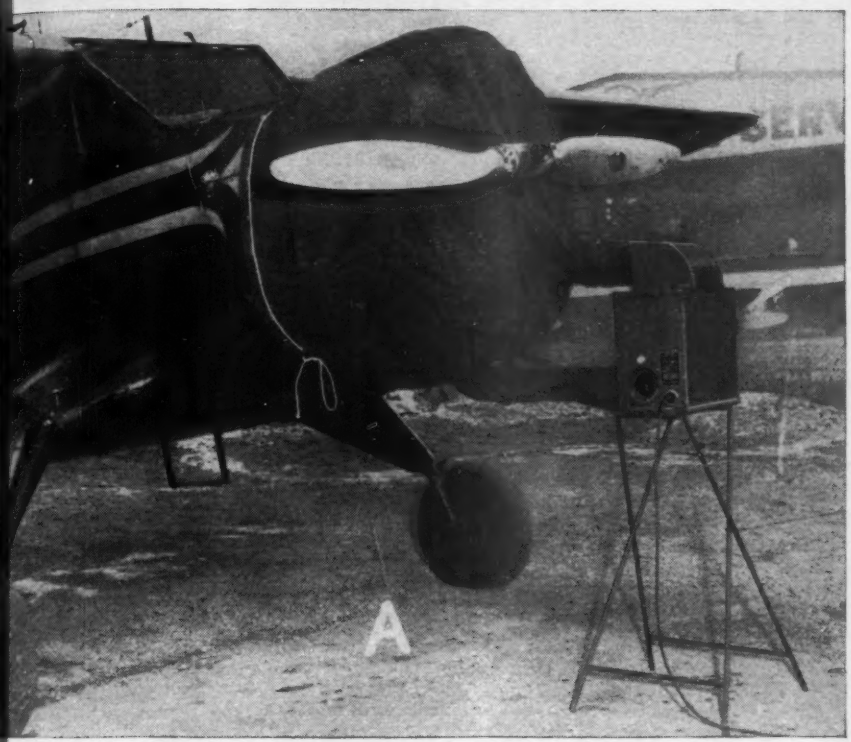


age grind that occurs in the first revs of an engine forced into a cold start.

Complete information on the Hunter Preheater, and delivery dates, may be obtained by writing or wiring Hunter and Co., 1550, E. 17th Street, Cleveland 14, Ohio.

(Advertisement)

HUNTER PRE-HEATERS SAVE HOURS—SAVE FUEL—SAVE ENGINES



he quickest, most economical and surest way to ready an xpensive aircraft engine is by pre-heating all working arts, before turning a single rev. We believe the surest, ost economical and quickest device for this purpose is a unter Universal Gasoline Pre-Heater. It is designed to be sed one unit to an engine, a method that makes possible hort, heat-saving ducts. The units are so simple and com- act that one man can easily handle them—set up and take own in a few minutes. Let us tell you more about them.

IMMEDIATE DELIVERY ON PRIORITIES

ULLETIN HB-3 ON REQUEST

HUNTER AND COMPANY

Aircraft Equipment

1550 E. 17th St.

CLEVELAND • OHIO

B G Corp., The
Bethlehem Equip. Corp., Ltd.
Bolton Mfg. Corp.
Briggs & Stratton Corp.
Delco Appliance Div.
Delco-Remy Div.
Eclipse Pioneer Div.
Edison-Splitdorf Corp.
Eisemann Corp.
Electric Auto-Lite Co.
Electric Sprayit Co., The
Eveready Hardware Mfg. Co., Inc.
Ford Motor Co.
General Armature Corp.
General Electric Co.
Heyer Prods. Co., Inc.
Himmel Bros. Co., The
International Metal Hose Co.
Lane-Wells Co.
McInerney Plastics Co.
Menaugh-Dutterer Co.
Morse Co., F. W.
Packard Electric Div.
Panelyte Div.
Persons Corp., L. M.
Polaroid Corp.
Pollak Corp., Joseph
Post Electric Co.
Precision Products Co.
Prudential Mach. Corp.
Ritter Co., Inc.
Samson United Corp.
Scintilla Magneto Div.
Searle Aero Industries, Inc.
Smith Mfg. Co., Nathan R.
Sorensen & Co., Inc.
Speedometer Service & Accessories
Torrance Precision Mfg. Co.
Valley Moulding Co., Inc.
Wiggins Airways, Inc., E. W.
Worcester Stamped Metal Co.

50—INSTRUMENTS & PARTS

AC Spark Plug Div.
Abrams Instrument Corp.
Ace Manufacturing Corp.
Adamson, George H.
Advance Aircraft Tool Co.
Aero Instrument Co.
Aeromarine Instrument Co., Inc.
Air Associates, Inc.
Air Radio & Instrument Corp.
Aircraft Indicators Co.
Aircraft Instrument Service, Inc.
Aircraft Steel & Supply Co., The
Air-Parts, Inc.
Airpath Instrument Co.
Airplane Mfg. & Supply Corp.
Air-Safe Aircraft Instrument Co.
Airsealand Aircraft, Inc.
Alexander Tool & Mfg. Co.
Allen Tool Mfg. Div.
American Measuring Instruments
American Paulin System
American Radio Hardware Co.,
American Turbotor Corp.
Anderson & Sons
Annis Co., R. B.
Associated Button Co., Inc.
Autoflight Corp.
Automatic Electric Mfg. Co.
Aviometer Corp.
Aviquipo, Inc.
Bache & Co., Semon
Ballantine Laboratories, Inc.
Barbour-Stockwell Co.
Barco Mach. Prods. Co.
Bausch & Lomb
Bendix Aviation Corp., Phila.
Bendix Radio Div.
Biederman, A.
Bird Aircraft Products
Boes Co., The W. W.
Boston Auto Gage Co.
Bowser, Inc.
Breeze Corps., Inc.
Bristol Co.
Brown Instrument Co.
Buffalo Meter Co.
Burton-Rogers Co.
Cambridge Instrument Co., Inc.
Chace Co., W. M.
Chelsea Clock Co.
Cities Service Oil Co.
Clarostat Mfg. Co., Inc.
Clifford Mfg. Co.
Cole Electric Co.
Consolidated Engineering Corp.
Consolidated Instrument Corp.
Cox & Stevens Aircraft Corp.
Cramer Co., Inc., The R. W. F.
Crowe Name Plate & Mfg. Co.
Dearborn Gage Co.
DeJur-Amsco Corp.
Delco Appliance Div.
Deming Indicator Div.
Designers for Industry, Inc.
Die Cast Corp.
Ducomun Co., M.
Dura Plastics, Inc.
E F G Engineering Works, Inc.
Eastern Air Devices, Inc.
Eclipse Pioneer Div.
Edison Splitdorf Corp.
Electric Auto Lite Co.
Electro Products Labs.
Elgin National Watch Co.
Engelhard, Inc., Chas.
Engis Equip. Co.
Erie Resistor Corp.
Eveready Hardware Mfg. Co.,
Eversharp, Inc.
Expert Die & Stamp Co., The
Fairchild Aviation Corp.
Federal Products Corp.
Federal Telephone & Radio Corp.
Felsenthal & Sons, G.
Ferranti Electric, Inc.
Fischer & Porter Co.
Fisher & Porter Co.
Ford Instrument Co.
Formica Insulation Co., The
Foxboro Co.
Freeport Machine Works, Inc.
Friden Calculating Mach. Co.
Fulton Syphon Co., The
Gallien, R. P.
Garrett Corp., The
Gatti, Inc., Aurele M.
General Communications Co.
General Elec. Co.
Geophysical Instrument Co.
Gibson, Inc.
Goodyear Aircraft Corp.
Gordon Co., Claude S.
Grammes & Sons, Inc., L. F.
Green, Henry J.
Gurley, W. & L. E.
Hagedorn Engineering
Hamilton Watch Co.
Hammel, Riglander & Co., Inc.
Harvey Machine Co., Inc.
Hays Corp., The
Hi Standard Mfg. Corp.
Hickok Electrical Instrument Co.
Howell, Sherburne & Co.
Humble Oil & Refining Co.
Illinois Testing Laboratories, Inc.
Industrial Controller Div.
Industrial Tool & Die Wks., Inc.
Instrument Design, Inc.
Instrument Parts Corp.
International Mutoscope Corp.
J-B-T Instruments, Inc.
Jack & Heintz, Inc.
Jacobson & Co., Inc.
Jardur Import Co.
Jones Motrola Sales Co.
Joyce Aviation, Inc.
Kenyon Instrument Co.
King Engr. Corp.
Knickerbocker Devel. Corp.
Knight Morley Corp.
Kollsman Instr. Div.
L & W Parts Co.
Lacey-Weber Co.
Lackner Co., The
Lane-Wells Co.
Lawrence Aeronautical Corp.
Lear Avia., Inc.
Leeds & Northrup Co.
Liberty Engr. Co.
Librascope, Inc.
Liquidometer Corp., The
Longines Wittnauer Watch Co.
Lorenzen Industries
Lowry Electrical Co., Inc.
Luminous Processes, Inc.
Main Machine Co.
Manning, Maxwell & Moore, Inc.
Marshalltown Mfg. Co.
Manufacturers Machine & Tool Co., Inc.
McGrath St. Paul Co.
McInerney Plastics Co.
Mercury Tool & Die Co.
Merrill Engrg. Laboratories
Metron Instrument Co.
Miller Corp., Wm.
Miller Dial & Name Plate Co.
Miller-Robinson Co.
Mine Safety Appliances Co.
Minneapolis-Honeywell Regulator
Monrad Engr. Co.
Moto Meter Gauge & Equip. Div.
National Machine Products
New Haven Clock Co.
Northern Engraving & Mfg. Co.
Pacific Scientific Co.
Panelyte Div.
Paulson & Co., Henry
Peerless of America, Inc.
Pennsylvania Plastics Corp.
Permutit Co., The
Pioneer Instr. Div.
Plastic Prod. Co.
Plymold Corp.
Porter, P. L.
Production Engrg. Co.
Q-O-S- Corp.
RCA Mfg. Co.
Radio Frequency Laboratories
Radio Navigational Instrument
Reisner & Co., The W. H.
Reliable Spring & Wire Forms
Reynolds Molded Plastics, Div.
Rieber, Inc., Frank
Rieker Instrument Co.
Ritchie & Sons, Inc.
Ritter Co., Inc.
Robbins Co., J. R.
Robertshaw Thermostat Co.
Roburn Agencies, Inc.
Rochester Mfg. Co.
Rowe Industries
St. Louis Engineering Co.
Samson United Corp.
Saxl Instrument Co., Inc.
Service Recorder Co., The
Schuck Mfg. Co.
Scott Aviation Corp.
Seely Instrument Co., Inc.
Selenium Corp. of America
Sheffield Corp., The
Simpson Electric Co.
Sorensen & Co., Inc.
Sparkes Mfg. Co.
Sperry-Gyroscope Co.
Square D Co.
Standard Aircraft Prod., Inc.
Star Compass Co.
Stewart Warner Corp.
Sticht Co., Inc., Herman H.
Stow Mfg. Co., Inc.
Sturgess, Inc.
Superior Instruments Co.
Switch & Panel & Regulator Div.
Tagliabue Mfg. Co.
Taylor Instrument Cos.
Technical Development Co., Inc.
Techtmann Industries, Inc.
Teckna-Plastic Co., Inc.
Televiso Products, Inc.
Tex Machine Co.
Thompson Glass & Paint Co.
Thwing-Albert Instrument Co.
Torrance Precision Mfg. Co.
Trico Products Corp.
Triplett & Barton, Inc.
Triplett Electrical Instrument Co.
United Precision Prods. Co.
U. S. Gauge Co.
U. S. Radium Corp.
Universal Engrg. Corp.
V. & E. Manufacturing Co.
Veeder-Root, Inc.
Vendo Co., The
Vibration Specialty Co.
Vic Cleaning Mach. Co.
Wallace & Tiernan Co., Inc.
Waltham Watch Co.

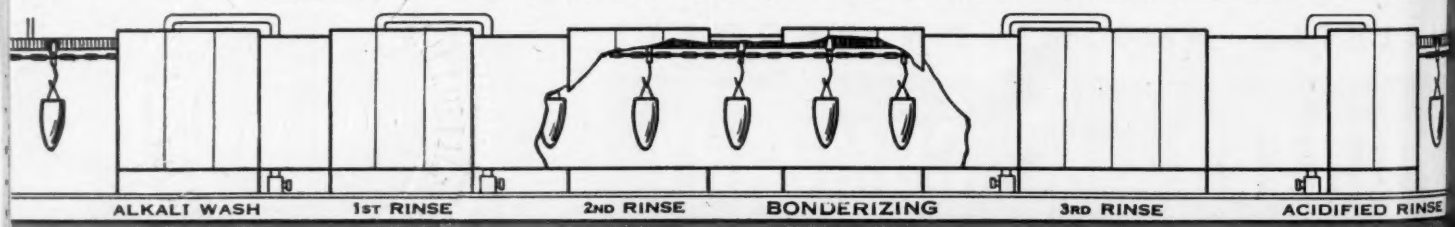
LET *Mahon* EQUIP YOUR PLANT FOR BONDERIZIN

In *Spray* Type Bonderizing (as illustrated) solution is sprayed against every surface of work being processed as it passes through on conveyor. Mahon also manufactures *Dip* Type Bonderizing equipment for use when more adaptable.

Mahon Bonderizing Equipment is built to fit your plant and product. All details of installation—type of conveyor — heating — controls, etc. — are given individual consideration.

Bonderizing long has been accepted as an outstanding method of producing an effective bond between paint and steel—and as a rust repellent. For as many years as the process has been in use, Mahon engineers have been planning, producing and installing equipment essential to its proper application. Hundreds of Mahon-engineered installations are now in operation—adapted to every conceivable size, shape and type of product. New requirements in airplane manufacture have established the need for bonderizing in many aircraft plants—and the demand for Mahon equipment. If manufacturing specifications call for the bonderizing of any of your parts, let Mahon design and build the equipment you'll need. Whether you require a bonderizing unit to fit into your present production line—or whether you desire a completely new and modern finishing system—including bonderizing—the knowledge and experience of Mahon engineers will prove immensely valuable. Production will be placed on a fast-moving, highly efficient and economical basis.

Typical Mahon Spray-Bonderizing installation. Next steps in production are through Drying Oven, Spray Booth and Baking Oven, also designed, built and installed by M



THE R. C. MAHON COMPANY

DETROIT CHICAGO

Manufacturers of Metal Cleaning Machines • Rust Proofing Machines • Hydro-Filter Spray Booths • Ovens of All Types • Filtered Air S
ply Units • Hydro-Foam Dust Collectors—and Many Other Units of Special Production Equipment—including Complete Finishing Syst

Warner & Swasey Co., The
Warren Engrg. Co., Inc.
Waterbury Clock Co.
Waterhouse Co.
Watlow Mfg. Co.
Watson-Stillman Co.
Wayne Div. Bendix Aviation
Wayne Pump Co., The
Weems System of Navigation
West Instrument Co.
Western Activities
Western Elec. Co. Specialty Prod.
Western Mfg. Supply Co.
Westinghouse Elec. & Mfg. Co. (Lima & Mansfield)
Weston Elec. Instr. Co.
White Rodgers Elec. Co.
Winn's Sons, J. H.
Zeiss, Inc., Carl

51—INSULATION & MATERIALS

Adel Precision Products Corp.
American Felt Co.
American Hair & Felt Co.
American Phenolic Corp.
American Radio Hardware Co.
Armstrong Cork Co.
Atlantic India Rubber Works
Atlas Asbestos Co.
Ault & Wiborg Corp.
Backstay Welt Co.
Bakelite Corp.
Barrett Division, The
Bellis Heat Treating Co.
Booth Felt Co., Inc.
Brand & Co., Wm.
Burlington Mills, Inc.
Carbide & Carbon Chem. Corp.
Carey Mfg. Co., The Philip
Celotex Corp., The
Central Process Corp.
Cole Electric Co.
Continental-Diamond Fibre Co.
Continental Felt Co.
Continental Rubber Wks.
Corning Glass Works
Dry-Zero Corp.
Dunbar Glass Corp.
Electronic Mechanics, Inc.
Fogel Refrigerator Co.
Formica Insulation Co., The
Franklin Fibre-Lamitex Corp.
Gasket Shop, The
General Ceramics & Steatite
General Electric Co.
General Tire & Rubber Co., The
Glidden Co.
Goodrich Co., The B. F.
Goodyear Tire & Rubber Co.
Gustin-Bacon Mfg.
Holfast Rubber Co., The
Homasote Co.
House & Sons, Inc., C. W.
Irvington Varnish & Insulator Co.
Johns-Manville
Kenwood Mills
Keyes Fibre Co.
Kimberly-Clark Corp.
Kirby Co., The
Lachman Co., Inc., Charles
Manufacturers Chemical Corp.
McInerney Plastics Co.
Mica Insulator Co.
Mitchell Rand Insulation Co.
National Automatic Fiber
New England Tape Co., Inc.
New Jersey Wood Finishing Co.
Northern Industrial Chemical Co.
Owens-Corning Fiberglas Corp.
Panelyte Div.
Perry-Austen Mfg. Co.
Phila Asbestos Co.
Plastic Prod. Co.
Precision Tube Co.
Quigley Co., Inc.
Reynolds Metals Co.
Richardson Co.
Rising, H. G.
Rochester Mach. Specialties
Rock Fibre Co.
Saylor Electric Products Corp.
Seaman Paper Co.
Searle Aero Industries, Inc.
Southern Friction Materials Co.
Standard Felt Co. Div.
Standard Varnish Works
Synthane Corp.
Taylor Fibre Co.
Tecknа-Plastic Co., Inc.
Tensolite, Corp., The
Union Asbestos & Rubber Co.
Van Cleef Bros.
Varflex Corp.
Virginia Rubatex Div.
Werner Co., Inc., R. D.
Western Felt Works
Westinghouse Elec. & Mfg. Co.
Westinghouse Elec. & Mfg. Co. (Lima Wks.)
Wilmington Fibre Spec. Co.
Zapon Keratol
Keratol Div.
Zophar Mills, Inc.

51a—JIGS see 22a

52—JOBBERS

A. I. D., Inc.
Abrasive Machine & Supply Co.
Ace Manufacturing Corp.
Adam Metal Supply Co.
Aero Supplies
Aeronautical Trading Co.
Aetna Plywood & Veneer Co.
Air Associates, Inc.
Air-Transport Equip., Inc.
Aircraft Exporting Corp.
Aircraft Instrument Service, Inc.
Aircraft Parts & Supply
Airsupply Company
Ajax Forge Co.
Alexander Tool & Mfg. Co.
American Aircraft Co., Inc.
Anderson Flax Fiber Co., Inc.
Anderson & Ireland Co., The
Atlantic Steel Products Co.
Aviation Supply Corp.
Ariquipo, Inc.
Aymond Co., Edward F.
Babb Co., Chas. H.
Barco Mach. Prods. Co.
Beals McCarthy & Rogers, Inc.
Benedict Miller Steel Co.
Blum & Co., Inc., Julius
Boyd Wagner Company
Brass & Copper Sales Co.
Bright Steel Corp.
Bruntons Automotive Service, Inc.
Burklyn Co.
Burton-Rogers Co.
Butcher Co., L. H.
California Refrigerator Co.
Campbell Hdwe. & Supply Co.
Canty, Inc., T. A.
Carey Machv. & Supply Co.
Carroll-McCreary Co., Inc.
Chamberlain Co.
Chanslor & Lyon Co.
Chautauqua Swaging Co.
Compton Shear Co., W. H.
Criterion Paper & Twine Co.
Davis Co., John H.
Day Rubber & Supply Co., John
Defiance Rubber Co.
Die Supply Co.
Dooley & Marinack Co.
Dycer Aviation Supplies
Erie Concrete & Steel Supply Co.
Edwards & Co., H. D.
Fasoldt & Son, Dudley F.
Fornaciari, Bert B.
Frazee Co., S. R.
Fuchs Machy. & Supply Co.
Gardner Co., J. R.
General Aircraft Supply Corp.
Giebel Mach. Tool Co.
Gillies Aviation Corp.
Grubb, Hobert N.
Hamilton Steel Co., The
Hockaday & Phillips, Inc.
Howard Fdry. Co.
Industrial Engrg. Co., Inc.
Intercontinent Corp., The
J. V. W. & Co.
Jonas & Son, Frank Sheridan
Joyce & Associates, J. C.
Keese Engineering Co.
Keystone Tool & Supply Co.
Kindt-Collins Co.
Kinmont Mfg. Co.
Lapham Hickey Co.
Lantz, Lester H.
LaSalle Furniture Co.
Long, S. A. Co., Inc., The
Los Angeles Heavy Hardware Co.
Lowry Electrical Co., Inc.
Marshall Co., E. & E.
Meltz Aircraft
Metal Fabricators, Inc.
Milford Rivet & Mach. Co.
Montgomery & Co., Inc.
Morris, Wheeler & Co.
National Pneumatic Co.
Neal & Brinker Co.
Neal Co., Inc., R. C.
Nelson Electric Supply Co.
New York Brass & Copper Co.
Nuttal-Styris Co.
Ort, Karl
Otto Aviation Corp.
Pacific Metal Co.
Payne & Co.
Petroleum Marketing Co.
Piper Aircraft Corp., Export Dept.
Potts, Son & Co., W. F.
Precision Aero. Corp.
Prince Rubber Co., Inc.
Presto Sales & Service, Inc.
Purdy, A. R.
Prods. Sales Corp.
Reading Machine Tool Co.
Renewal Service
Reuther Equip. & Paint Co.
Richter Engrg. Co.
Rising, H. G.
Roburn Agencies, Inc.
Roes & Co., H. A.
Ryan Co., Fred J.
S.A.E. Steels
Seattle Steel Co.
Seifreat-Elstad Machinery Co.
Shaw & Co.
Shearcut Tool Co.
Smith-Courtney Co.
Speedometer Service & Accessories
Stafford Tool Die & Mach. Co.
Standard Parts Corp.
Stevens, Inc., Fred B.
Stritt & Priebe, Inc.
Summit Ind. Prod. Co.
Supply Div.
Thompson Glass & Paint Co.
Trader Aero Supply
Trans-American Airports Corp.
Travers Tool Co.
Tri-State Supply Corp.
Tubular Alloy Steel Corp.
United Aircraft Parts Mfg. Co.
United Sanitary Chemicals Co.
U. S. Rubber Co.
U. S. Steel Supply Co.
Vimlert Co., Ltd., The
Whitehead Metal Prod. Co.
Wright & Wilelmy Co.

52(a)—JOINTS AND COUPLINGS

Aircraft Fitting Co., The
Borg-Warner Corp.
Cal-Air Prod. Co.
Chiksan Tool Co.
Detroit Gear Aircraft Parts Div.
Ohio Aero Accessories, Inc.
Screw Machine Products Co., Inc.
Teurek Mfg. Co., J. J.
Wiggins Oil Tool Co., Inc., E. B.

52(b)—LABELS, NAMES PLATES, DECALCOMANIAS

American Decalcomania Co., Inc.
American Tag Co.
Anderson & Sons
Avery Adhesives
Bastian Bros. Co.
Blinn & Associates, Benn
Campbell Box & Tag Co.

FOR FINER
FASTER FINISHING
Use DREMEL MOTO-TOOLS
Model 2 Moto-Tool, complete with accessories, as illustrated, in felt-lined hardwood case—$23.50. Model 2 Moto-Tool only, with emery wheel point — $16.50.
27,000
R.P.M.

Used in machine shops and tool rooms for finishing intricate dies. Used on production lines to clean castings, turnings and forgings . . . sharpen tools and do hundreds of grinding, finishing, polishing, burring, routing and etching operations.

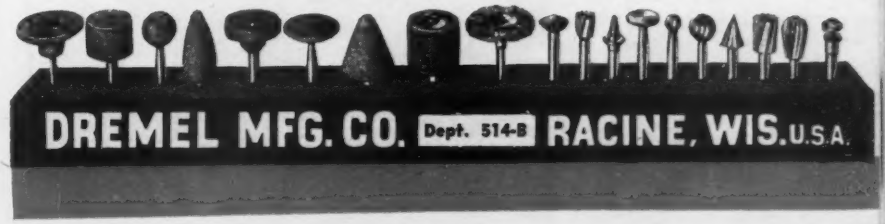
Dremel Moto-Tool has AC-DC motor with shock-proof bakelite housing, oil-sealed (oil-less) bearings, and built-in cooling fan. Weighs only 13 ounces —so light and compact a *girl* can handle it with ease. Dynamically balanced armature eliminates vibration and provides precision control. Moto-Tool's high speed (27,000 rpm) permits finer, faster work—conserves cutters.

Dremel Moto-Tools are proving indispensable aids in speeding up war production in such plants as General Electric, Westinghouse, Remington Arms, Ford, Nash-Kelvinator, Consolidated Aircraft, Douglas and Northrup Aircraft, and many similar "Arsenals of Democracy."

10 DAY TRIAL

Try a Dremel Moto-Tool on your own jobs—in your own shop. See how versatile, how indispensable it is—how it saves time and materials. Order from your distributor. If he cannot supply you — write factory. PROMPT SHIPMENT on orders with proper priority.

Whether you have a Moto-Tool or any other type of grinder, use only genuine Dremel shop-tested Accessories — steel cutters, grinding points, brushes, sanders, etc. Write for literature.



DREMEL MFG. CO. Dept. 514-B RACINE, WIS. U.S.A.

Century Lighting, Inc.
Criterion Decalcomanias Co., The
Denney Tag Co., The
Dix Mfg. Co.
Dura-Prods. Mfg. Co.
Etching Co. of America
Fox Co.
Meyercord Co.
National Decalcomania Corp.
Palm, Fechteler & Co.
Printloid, Inc.
Stanley Mfg. Co., The
Stoeffel Seals Co., Inc.
Teckna-Plastic Co.
Western Lithograph

53—LANDING GEAR EQUIPMENT

A & F Aluminum Prods. Co.
Aerco Corp.
Aeronautical Products, Inc.
Air Associates, Inc.
Airchox Co. Div.
Aircraft Accessories Corp. (Cal.)
Aircraft Development Co.
Aircraft Mechanics, Inc.
Aircraft Products, Inc.
Aircraft Welders, Inc.
American Aviation Corp.
American Brake Shoe Co.
American Metal Products Co.
Ampco Metal, Inc.
Applegate Amphibians
Atlantic Diesel Corp.
Aviation Engineering, Inc.
Aviation Parts, Inc.
Baldwin-Duckworth Div.
Barco Mfg. Co.
Ben Mfg. Co., The
Bendix Products Div.
Black, Sivals & Bryson, Inc.
Bournonville Welding & Machine
Bridgeport Worm & Gear Mfg.
Brown Lathe & Tool Co.
Chamberlin Metal Weatherstrip
Clarke Aero-Hydraulics, Inc.
Cleveland Aircraft Products Co.
Cleveland Pneumatic Tool Co.
Columbia Aircraft Industries
Columbia Aircraft Products, Inc.
Cosco Mfg. Co.
Dalco, Inc. of Delaware
Davis-Westholt, Inc.
Del-Air Corp.
Dill Mfg. Co.
Eclipse Pioneer Div.
Edwards Co.
Electric Sprayit Co., The
Evans Products Co.
Ex-Cell-O Corp.
Expert Die & Stamp Co., The
Firestone Aircraft Co.
Fletcher Aviation Corp.
Foote Bros. Gear & Mach. Corp.
Fulton Co., The
Gatke Corp.
General Tire & Rubber Co., The
Gladden Prods. Div.
Glidden Buick Corp.
Goodyear Aircraft Corp.
Goodyear Tire & Rubber Co., Inc.
Graham-Paige Motors Corp.
Greer Hydraulics
Hardware Specialties Mfg. Co.
Harvard Lock Co.
Hawley Prod. Co.
Hayes Industries, Inc.
Heath Co.
Herman Machine & Tool Co., The
Hi Standard Mfg. Corp.
Hockaday Aircraft Corp.
Hofco Pump, Ltd.
Hoof Prods. Co.
Houde Engrg. Div.
Hub Industries, Inc.
Hughes Tool Co.
Kelsey Taues Wheel Co.
Keystone Aircraft Products, Inc.
Kinmont Mfg. Co.
Lake State Prods., Inc.
Lear Avia., Inc.
Lester Industries, Inc.
Link-Belt Speeder Corp.
Luscombe Airplane Corp.
Marlin Firearms Co.
Mawaco Machine Co.
Menasco Mfg. Co.
Miller-Robinson Co.
Motor Wheel Corp.
Mullins Mfg. Corp.
National Pneumatic Co.
Olds Alloy Co.
Oliver Farm Equip. Co.
Pacific Aviation, Inc.
Pacific Car & Foundry Co.
Peninsular Metal Prods. Corp.
Pitkin Mach. Wks.
Potter, Inc., L.
Raybestos-Manhattan, Inc.
Reasor Mfg. Co.
Reisner Mfg. Co., Inc., The
Rheem Mfg. Co.
Rowe Industries
St. Louis Aircraft Corp.
Sandsea Co., Harry
Saylor-Beall Mfg. Co.
Scott Aviation Corp.
Sheller Mfg. Corp.
Shinn Devices Co.
Simmons Mfg. Co., The
Smith Corp., A. O.
Special Mach. Tool Engrg. Wks.
Spier Aircraft Corp.
Starbird, Geo. A.
Swan Eng. Co., Inc.
Symmetric Mfg. Co.
Tammany Mach. Shop
Thermoid Co.
TraderOAero Supply, Bob
Tuthill Pump Co.
Tycoon Tackle, Inc.
Tyler Fixture Corp.
U. S. Spring & Bumper
United Aircraft Products, Inc.
Universal Aircraft Co.
Wallace Supplies Mfg. Co.
Western Gear Works
Western Mfg. & Supply Co.
Wheeling Bronze Casting Co.
White Aircraft Corp.
Wood Elastic Web Co., J. W.
Zamax Mfg. Co.

54—LIGHTING EQPT.—FOR AIRCRAFT

Acme Metal Spinning Co.
Adams & Westlake Co.
Air Associates, Inc.
Aircraft Instrument Service, Inc.
Aircraft & Marine Specialty Co.
Altens Fdry. & Machy. Wks.
Aluminum Gds. Mfg. Co.
American Liquid Gas Corp.
American Radio Hardware Co.
Appleton Elec. Co.
Arrow Safety Devices Co.
Avia. Products Co.
Bardwell & McAlister
Bogue Elec. Co.
Clarostat Mfg. Co., Inc.
Cole Electric Co.
Cole-Hersee Co.
Cole Steel Equipment Co., Inc.
Curtis Lighting, Inc.
Dalco, Inc. of Delaware
Dayton Mfg. Co., The
Dossert & Co.
Duro Test Corp.
Douglas Mfg. Co., H. A.
Dunbar Glass Corp.
E. A. Laboratories, Inc.
Electric Arc, Inc.
Electric Sprayit Co., The
Electronic Laboratories, Inc.
Falge Engrg. Service
Federal Elec. Co., Inc.
Garfield Electrical Supply Co.
General Armature Corp.
General Electric Co.
General Elec. Co. (Conn.)
General Electric Co. (Nela Park)
Gothard Mfg. Co.
Griffith-Hope Co.
Grimes Mfg. Co.
Guth Co., The, Edwin F.
Hall Lamp Co., C. M.
Holophane Co.
Illuminated Guide Line, Inc.
K. D. Lamp Co.
Keese Engineering Co.
Kenyon Instrument Co.
Kopp Glass, Inc.
Kulka Elec. Mfg. Co., Inc.
Leahy Co., Dave
Lights, Inc.
Littelfuse Co.
Luminator, Inc.
McInerney Plastics Co.
McPhilbin Mfg. Co.
Mitchell Mfg. Co.
New Jersey Fulgent Co.
Peterson, F. Somers Co.
Radiant Lamp Corp.
Revere Elec. Mfg. Co.
Reynolds Molded Plastics Div.
Robertson Co., H. H.
Rodman & Co.
Rusgreen Mfg. Co.
S. & M. Lamp Co.
St. Louis Engineering Co.
Samson United Corp.
Searle Aero Industries, Inc.
Sorensen & Co., Inc.
Tex Machine Co.
Thermador Elec. Mfg. Co.
Tung-Sol Lamp Wks., Inc.
Westinghouse Elec. & Mfg. Co. (Cleve.)
Yankee Metal Products Corp.

55—LIGHTING—AIRPORT & SHOP

Acme Metal Spinning Co.
Adams & Westlake Co.
Airplane Mfg. & Supply Corp.
American Airport Equipment Co.
American Gas Accumulator Co.
American Liquid Gas Corp.
Appleton Electric Co.
Arnolt Motor Co.
Automatic Electrical Devices Co.
Bardco Mfg. & Sales
Bright Light Reflector Co., Inc.
Caterpillar Tractor Co.
Century Lighting, Inc.
Cramer Co., Inc., The, R. W.
Crouse-Hinds Co.
Davey Compressor Co.
Dazor Mfg. Corp.
Drake Mfg. Co.
Duro Test Corp.
Electric Arc, Inc.
Electrolux Corp.
Electronic Laboratories, Inc.
Federal Elec. Co., Inc.
Fernholtz Machinery Co.
Fostoria Pressed Steel Corp., The
Garfield Electrical Supply Co.
General Elec. Co. (Conn.)
General Electric Co. (Nela Park)
Edwin F. Guth Co., The
Heyer Prods. Co., Inc.
Holophane Co., Inc.
Illuminated Guide Line, Inc.
International Engr., Inc.
Johnson Ventlite Co.
K. D. Lamp Co.
Keese Engineering Co.
Ken-Rad Tube & Lamp Corp.
Kliegl Bros.
Kopp Glass, Inc.
Kulka Elec. Mfg. Co., Inc.
Larrimore Sales Co.
Lights, Inc.
Lister-Blackstone, Inc.
Lowry Electrical Co., Inc.
Luminator, Inc.
Mervin Industries, Inc.
Miller Co., The
Mitchell Mfg. Co.
Neon Lights, Inc., Claude
New-Bait Stamping & Mfg. Co.
Pyle-National Co., The
Q. R. S. Neon Corp., Ltd.
Radiant Lamp Corp.
Revere Elec. Mfg. Co.
Roburn Agencies, Inc.
Rusgreen Mfg. Co.
Safway Steel Products, Inc.
St. Louis Engineering Co.
Searle Aero Industries, Inc.
Steber Mfg. Co.
Sterling Electric Co.
Trippe Mfg. Co.
United States Motors Corp.
Universal Motor Co.
Wabash Photolamp Corp.
Wakefield Brass Co., The F. W.
Westinghouse Elec. & Mfg. Co.
Westinghouse Electric & Mfg. Co. (Lima & Cleve.)
Wheeler Reflector Co.
Wiley, Inc., R. & W.
Wiremold Co., The

56—LUBRICANTS, OILS & GREASE

Acheson Colloids Corp.
Alox Corp.
American Liquid Gas Corp.
Atlantic Refining Co.
Bethlehem Equip. Corp., Ltd.
Black Bear Co., Inc.
Cities Service Oil Co.
Crane Packing Co.
Dixon Crucible Co.
Dockson Corp.
Ethyl Corp.
Fannon Co., Inc., J. L.
Fiske Brothers Refining Co.
Galena Oil Corp.
General Petroleum Corp.
Gredag Corp.
Gulf Oil Corp. (Aviation Dept.)
Halowax Products Div.
Hammel, Riglander, Inc.
Harman Equipment Co.
Hollingshead Corp., R. M.
Houghton & Co., E. F.
Humble Oil & Refining Co.
Lincoln Engr. Co.
Lowry Electrical Co., Inc.
Kendall Refining Co.
Kerns Co., Inc., L. R.
Keystone Lubricating Company
Lehigh Chemical Products Co.
Lubriplate Div. (Fiske Bros. Ref. Co.)
Magnus Chem. Co.
Mid-Continent Petroleum Corp.
National Motor Bearing Co., Inc.
Pennsylvania Grade Crude Oil
Pennsylvania Refining Co.
Pennzoil Co., The
Petroleum Marketing Co.
Phillip Petroleum Co.
Phoenix Oil Co., The
Pioneer Pump Mfg. Co.
Pure Oil Co., The
Puritan Co., Inc.
Quaker Chem. Prods. Corp.
Quaker State Oil Refining Corp.
Refiners Lublicating Co.
Rheem Mfg. Co.
Rol-Pak Co.
Royal Engineering Co.
Shell Oil Co., Inc.
Sinclair Refining Co.
Socony-Vacuum Oil Co., Inc.
Sonneborn Sons, Inc., L.
Specialty Products Co.
Standard Oil Co.
Standard Oil of N. J.
Stewart Warner Corp.
Texas Co., The
Union Carbide & Carbon Corp.
Union Oil Co. of Cal.
United Lubricant Co., The
United Oil Mfg. Co.
Valvoline Oil Co.
Waverly Petroleum Prod. Co.

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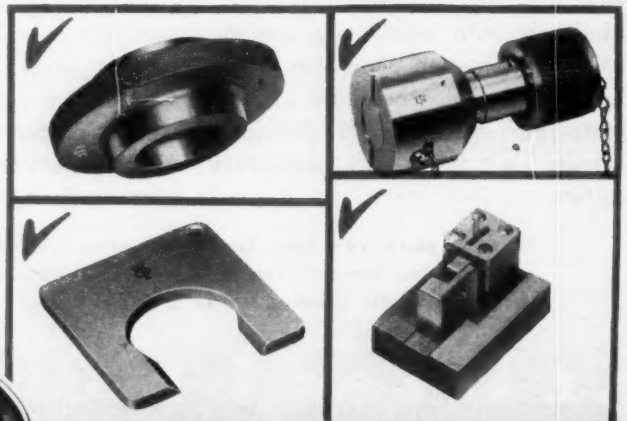

TURNER GAUGE GRINDING COMPANY
2625 HILTON ROAD • • • • FERNDALE, MICH.

Wayne Chem. Prod. Co.
White & Bagley Co.
Withrow Co.
Wolf's Head Oil Refining Co.
Wolverine-Empire Refining Co.
York Shipley, Inc.

57—MACHINE SHOP WORK

A & D Machine Co.
Abaker & Son
Abrams Instrument Corp.
Absco Welded Products Co.
Acmatool Co., Inc.
Ace Manufacturing Corp.
Acme Engrg. Co.
Acme Pattern & Tool Co., Inc.
Acromark Co., The
Active Screw & Mfg. Co.
Advance Aircraft Tool Co.
Advance Spring Corp.
Aereo Corp.
Aerial Mach. & Tool Corp.
Aero Bolt & Screw Co.
Aero Components Mfg. Co.
Aero Die & Stamping Co.
Aero Services
Aeronautical Machinists
Aeronautical Mfg. Corp.
Agawam Aircraft Products, Inc.
Air Associates, Inc.
Air Control Products, Inc.
Aircraft Containers Co.
Aircraft Engrg. Products, Inc.
Aircraft Industries Co.
Aircraft & Marine Specialty Co.
Aircraft Mechanics, Inc.
Aircrafts Parts Production Corp.
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Yoder Co., The
York Corrugating Co.
York Safe & Lock Co.
York-Shipley, Inc.
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Zell Corp.

57a—METALLIZING see 68

58—METALS

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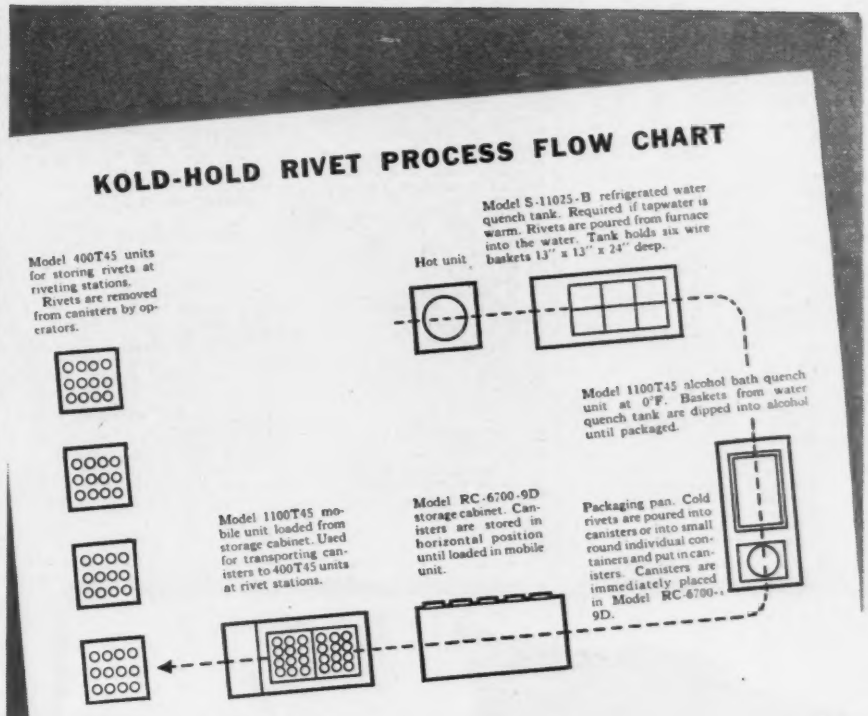
KOLD-HOLD RIVET PROCESS FLOW CHART
Model 400T45 units for storing rivets at riveting stations. Rivets are removed from canisters by operators.
Hot unit
Model S-11025-B refrigerated water quench tank. Required if tapwater is warm. Rivets are poured from furnace into the water. Tank holds six wire baskets 13" x 13" x 24" deep.
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Model 1100T45 mobile unit loaded from storage cabinet. Used for transporting canisters to 400T45 units at rivet stations.
Model RC-6700-9D storage cabinet. Canisters are stored in horizontal position until loaded in mobile unit.
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59—METEOROLOGICAL EQUIPMENT

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MODELS, PLANE & WIND TUNNEL, see 90

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Dayton Electric Mfg. Co.
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Electric Products Co., The
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Sorensen & Co., Inc.
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Toledo Standard Commutator Co.
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U. S. Electrical Motors, Inc.
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Westinghouse Elect. & Mfg. Co.
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61—MOUNTS—ENGINE

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Aircraft Mechanics, Inc.
Aircraft Products, Inc.
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American Metal Products Co.
American Safety Razor
American Tube Bending Co.
Arnolt Motor Co.
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Bowling Green Rubber Co.
Bushings, Inc.
Butler Mfg. Co.
Carrier Corp.
Clayborne Mfg. Co.
Colson Corp.
Conn. Hard Rubber Co.
Continental Rubber Wks.
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Del-Air Corp.
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Detroit Sheet Metal Works
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Essick Mfg. Co.
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Goodyear Tire & Rubber Co., Inc.
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Southern Friction Materials Co.
Swan Eng. Co., Inc.
Taylorcraft Avia. Corp.
Technical Welding Co.
Tex Machine Co.
Transcontinental Machine & Tool
Tyler Fixtures Corp.
Tyson Bearing Co.
U. S. Rubber Co.
Universal Bldg. Prods. Corp.
Wallace Supplies Mfg. Co.
Welded Aircraft Parts Co.
Wells Aircraft Parts Co.
West American Rubber Co.
Western Arc Welding, Inc.
White Aircraft Corp.

62—OXYGEN EQUIPMENT, FLIGHT

Air Cruisers, Inc.
Air Reduction Sales Co.
American-LaFrance Foamite Corp.
Aro Equipment Corp.
Bastian-Blessing Co.
Burdett Oxygen Co.
Chicago Metal Hose Corp.
Clifford Mfg. Co.
Corpus Christi Oxygen Co.
Eclipse-Pioneer Div.
Firestone Aircraft Co.
Firestone Steel Prods. Co.
Gaertner Scientific Corp., The
General Aircraft Equipment, Inc.
General Scientific Equip. Co.
Goodrich Co., The, B. F.
Hagedorn Engineering
Hays Corp., The
J O Mfg. Co.
Kelsey Hayes Wheel Co.
Linde Air Prods. Co.
Mobile Refrigeration, Inc.
Modern Engrg. Co., Inc.
Ohio Chemical & Mfg. Co.
Ohio Rubber Co.
Peerless of America, Inc.
Phoenix Trimming Co.
Pioneer Instr. Bendix Avia.
Pressed Steel Tank Co.
Puritan Compressed Gas Corp.
Rochester Mfg. Co.
Scott Aviation Corp.
Smith Mfg. Co., F. A.
Southern Oxygen Co., Inc.
Standard Safety Equipment Co.
Waterhouse Co.
Wire Cloth Products, Inc.

63—PARACHUTES & FITTINGS

Accessory Forgings Co.
Aerial Mach. & Tool Corp.
Airchox Co., Div.
American Chain & Cable Co., Inc.
American Lady Corset Co.
Arnolt Motor Co.
Aviquipo, Inc.
Bokelman Co., Inc.
Buffalo Weaving & Belting Co.
Buser Silk Corp., R. G.
Charles Mfg. Co.
Cole of California, Inc.
Corbin, P. and F.
Cortland Line Co., Inc.
DeLong Hook & Eye Co.
Dennison Mfg. Co.
Duplan Corp.
du Pont de Nemours & Co., Inc., E. I. (Wilmington)
Eagle Parachute Corp.
Fashion Frocks, Inc.
Follmer Clorr & Co.
Fowler Aircraft Co.
Gorham Mfg. Co., The
Gudebrod Bros. Silk Co., Inc.
Hawley Prods. Co.
Hayes Mfg. Corp.
Heminway & Bartlett Mfg. Co.
Irving Air Chute Co.
Joyce Aviation, Inc.
McInterney Plastics Co.
Menihan Corp., J. G.
Narrow Fabric Co., The
National Automotive Fibres, Inc.
Ohio Chemical & Mfg. Co.
Panelyte Div.
Pantasote Co., The
Parachute Corp. of America, The
Peterson, F. Somers Co.
Pioneer Parachute Co.
Maine Industries Co.
Reading Air Chutes, Inc.
Reliance Mfg. Co.
Rice Co. A. M.
Schlegel Mfg. Co., The
Scholl Mfg. Co., Inc., The
Security Parachute & Equipment
Shannock Narrow Fabric Co.
Skylark Mfg. Co., Inc.
Sponge Rubber Products Co.
Standard Parachute Corp.
Switlik Parachute Co.
Triangle Parachute Co.
Tyer Rubber Co.
United-Carr Fastener Corp.
Zip-A-Bag Corp.

64—PHOTOGRAPHIC EQUIPMENT

Abrams Instrument Corp.
Adel Precision Products Corp.
Aero Service Corp.
Agfa Ansco Div. Gen. Aniline
American Cellulose Co.
American Photocopy Equipment
Auld Co., The, D. L.
Azalid Products Div.
Bardwell-McAlister
Bausch & Lomb Optical Co.
Bell & Howell Co.
Boes Co., The W. W.
Craftint Mfg. Co., The
DeJur-Amsco Corp.
du Pont de Nemours & Co., Inc., E. I. (Wilmington)
Eastman Kodak Co.
Fairchild Aerial Surveys, Inc.
Fairchild Aviation Corp.
Filtrine Mfg. Co.
Folmer Graflex Corp.
Haloid Co.
Herrn Optical Co.
Highbridge-International Co.
Houston Corp.
Howell, Sherburne & Co.

For faster delivery

specify **DEARBORN** **GAGE BLOCKS**

THE DEARBORN GAGE COMPANY is able to make faster deliveries on their gage block sets, since the introduction of increased production facilities in their plant.

For those manufacturers who are in urgent need of Dearborn's Chromium Plated Gage Block Sets the Dearborn Gage Company guarantees reasonably prompt deliveries.

WRITE FOR THIS BOOK

This Booklet entitled, "How To Make Your Standards Last Longer," will give you some valuable information on the proper care of gage blocks. Please write on your company stationery giving your title or position, and this booklet will be sent to you.

Distributors in the principal cities of the United States and Canada.

DEARBORN GAGE CO. 2203 BEECH STREET DETROIT, MICHIGAN

Originators of Chromium Plated Gage Blocks

PHYSICAL AND CHEMICAL PROPERTIES OF "dag" COLLOIDAL GRAPHITE

1 **Slippery—a Good Lubricant. Softer than talc**

2 **Conducts Electricity**

3 **Withstands Temperature Extremes**

4 **Absorbs, Radiates and Conducts Heat**

5 **Maximum Purity**

6 **Low Coefficient of Expansion**

7 **Particles Bear Like Electric Charges**

8 **Insoluble in Acids and Alkalies**

9 **Black and Opaque**

10 **Gas Adsorbent**

11 **Little Photoelectric Effect**

12 **Miscible with Most Fluids**

13 **Films Adhere Tenaciously and Dry with Sharp Edges**

14 **Microscopically Fine Particles.**

15 **An Excellent Suspension**

Available as a smooth, black, liquid concentrate, Dag colloidal graphite puts a versatile company of physical and chemical properties at your service. Fifteen of the more important of these properties are listed here with a different color given to each for easy reference.

Match these properties by color with the colors on the medals below. Each medal represents a typical performance "citation" to Dag colloidal graphite. Dozens more could be shown, if space permitted, because this product is a dry film, a fluid film, a surface coating, an impregnation—and a few other things besides.

"Mr. Dag"

2 14 13 15

2, 14, 13, 15
CITATION: "Drive belts and other nonconductors traveling at high speed accumulate static charges which under certain conditions may constitute a hazard. This static electricity is controlled and bled-off harmlessly by a Dag colloidal graphite conductive film."

1 3 5 14 15

1, 3, 5, 14, 15
CITATION: "When the work rotating chuck of this large honing machine was assembled and run-in using Dag colloidal graphite, running-in time was reduced approximately 35%, operating temperature dropped considerably, and the danger of bearing damage due to temporary oil film failure was eliminated."

9 13 6 14 15

9, 13, 6, 14, 15
CITATION: "Dag colloidal graphite is used to retouch photograph negatives because of its complete opacity, because a film of minimum thickness is required and because it dries with a sharp edge."

PIN A MEDAL ON YOURSELF!

CHECK THE LIST and pick out those properties which you can use. Then state your problem to us and let our engineers give you the benefit of their experience. It is quite possible that they have already studied a parallel application. You'll pin a medal on yourself for calling in Mr. Dag.

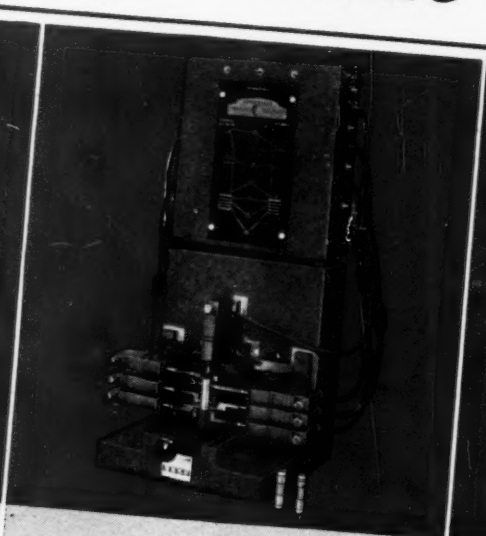
Dag, Oildag, Aquadag, Castordag, Glydag and Prodag are registered trade marks of Acheson Colloids Corporation.
Copr. 1944 by Acheson Colloids Corp.

dag COLLOIDAL PRODUCTS

ACHESON COLLOIDS CORPORATION
PORT HURON, MICHIGAN

Increase SPEED AND ACCURACY WITH SHEFFIELD PRECISION GAGING INSTRUMENTS

The Visual Gage, having magnifications of 500 to 20,000 to 1, is used for checking reference and production gages, purchased parts on arrival, for process and production inspection, laboratory and research work. It checks external dimensions and the pitch diameter of screw threads.



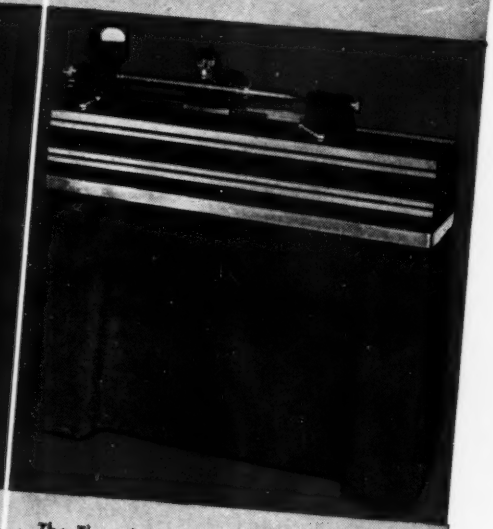
The Multichek is a combination gage which checks simultaneously a number of critical dimensions, indicating by light signals whether each dimension is within, above or below tolerance limits. A master signal may be used to integrate all individual signals for maximum speed in checking.

The Precisionaire is an air flow gage for the checking of internal diameter, taper and out-of-round on long and/or small bores such as rifle barrels and other relatively inaccessible holes. The gage may be presented to the work, Model A, or the work brought to the gage, Model B.

The Internalgage checks hole diameter and out-of-round with the same precision as external dimensions are checked on the Visual Gage—special application for checking piston.

The Electrichek is used to show instantly by signal lights whether a dimension is within tolerance, undersize or oversize. It is used as an inspection gage or it can be mounted directly on a machine to check parts before they are unloaded or to stop the machine when the part is brought to size.

Descriptive literature available upon request



The Thread Lead Checking Instrument is a combination electrical and mechanical device for checking the lead of screw threads or rack teeth. Precision gage blocks are used as a direct reference. A Super-Precision Micrometer facilitates ease and speed of an accurate set-up and the checking operation.

ARMY E NAVY

SHEFFIELD MASTER CRAFTSMEN

THE SHEFFIELD CORPORATION

Dayton 1, Ohio, U.S.A.

MACHINE TOOLS • GAGES • MEASURING INSTRUMENTS • CONTRACT SERVICES

International Mutoscope Corp.
Jowlin, Inc., Metal Products
Kliegl Bros.
Lackner Co., Inc., The
Leitz, Inc., E.
Lights, Inc.
Macbeth Arc Lamp Co.
Miller-Robinson Co.
Mitchell Camera Corp.
Morse Instrument Co., The
Motoflex Camera Corp.
National Photocolor Corp.
Neumade Products Corp.
Pease Co., The, C. F.
Photo Record Equip. Co.
Photo Reprod. Equip. Co.
Photoprint Co.
Precision Eng. Co.
Polaroid Corp.
Q-O-S Corp.
Q. R. S. Neon Corp., Ltd.
Raven Screen Corp.
Reynolds Molded Plastics
Roburn Agencies, Inc.
St. Louis Radio Engineering Co.
Simplex Specialty Co., Inc.
Sky View Camera Co.
Speidel Co., Chas. W.
Southern Cal. Plating Co.
Star Pattern Wks.
Temprite Products Corp.
Thompson Glass & Paint Co.
Troy Sunshade Co.
Twin City Tool Co.
Wabash Photolamp Corp.
Weston Elec. Instr. Co.
Wollensak Optical Co.
Zeiss, Inc., Carl

65—PISTONS & RINGS

Aeronautical Trading Co.
Air-Parts, Inc.
Alexander Tool & Mfg. Co.
Aluminum Alloys Corp.
Aluminum Co. of America
American Hammered Piston Ring
Borg Warner Corp.
Burd Piston Ring Co.
Day Piston Corp., Ray
Delco-Remy Div.
Duro Co.
Detroit Gear Aircraft Parts Div. (Borg Warner)
Hastings Mfg. Co.
Henkle & Joyce Hdw. Co.
Hockaday & Phillips, Inc.
Hudson Motor Car Co.
Industrial Washing Mach. Corp.
International Piston Ring Co.
Koppers Co., Div.
McQuay-Norris Mfg. Co.
Moss & Co., Henry
Muskegon Piston Ring Co.
Nylen Products Co.
Ohio Piston Co., The
Pacific Piston Ring Co.
Perfect Circle Co., The
Plastic Prod. Co.
Production Tooling Co.
Ramsey Accessories Mfg. Corp.
Richmond Ring Co.
Robbins Co., J. C.
Sealed Power Corp.
Simplex Prod. Corp.
Speedometer Service & Access.
Steel & Bronze Piston Ring Co.
Sterling Aluminum Prod., Inc.
Tube Turns, Inc.
U. S. Hammered Piston Ring
Westinghouse Air Brake Co.
Wilkening Mfg. Co.

66—PLASTICS—MATERIALS

Adhere, Inc.
Aeronautical Trading Co.
Aircraft Production Corp.
Air-Parts, Inc.
American Cyanamid Co.
American Gauge Co., The
American Radio Hardware Co.
Anderson Flax Fiber Co., Inc.
Andrews Hardware & Metal Co.
Auburn Button Works, Inc.
Aviation Equipment Sales Corp.
Bakelite Corp.
Blue Jay Aeronautical Company
Blum & Co., Inc., Julius
Burndy Eng. Co., Inc.
Carbide & Carbon Chem. Corp.
Catalin Corp.
Celanese Celluloid Corp.
Cellulose Prods. Co.
Central Process Corp.
Columbia Aircraft Products, Inc.
Columbian Rope Co.
Commercial Plastics Co.
Consolidated Water Pur.
Continental-Diamond Fibre Co.
Craftint Mfg. Co., The
Crescent Panel Co.
Crofut Co., Willard
Dade Bros., Inc.
Dockson Corp.
du Pont de Nemours & Co., Inc. E. I. (Plastics Dept.)
du Pont de Nemours & Co., Inc., (Wilmington)
Dura Plastics, Inc.
Duramold, Div.
Durez Plastics & Chemicals, Inc.
Durite Plastics, Inc.
Electric Auto Lite Co.
Erie Resistor Corp.
Federal Elec. Co., Inc.
Felsenthal & Sons, G.
Fessenden Hall
Firestone Aircraft Co.
Formica Insulation Co., The
Franklin Fibre-Lamitex Corp.
Fuller & Co., W. P. (L.A.)
General Electric Co.
Goodrich Co., The, B. F.
Goodyear Tire & Rubber Co., Inc.
Gordon-Lacey Chem. Prods. Co.
Haloway Products Div.
Hayes Mfg. Corp.
Heath Co.
Hercules Powder Co.
Holfast Rubber Co., The
Horn Co., A. C.
Industrial Synthetics Corp.
Insulating Fabricators, Inc.
Johns-Manville
Kellogg Switchboard & Supply
King Plastics Corp.
Kirby Co., The
Kirk Plastic Corp.
Knoedler Co., A.
Lights, Inc.
Lowry Electrical Co., Inc.
McInerney Plastics Co.
Manufacturers Chemical Corp.
Mansion House Furniture Co.
Masonite Corp.
Metal Goods Corp.
Mica Insulator Co.
Monsanto Chem. Co., Plastics
Morrow Aircraft Co.
Nat'l. Vulcanized Fibre Co.
Nixon Nitration Wks.
Nobell Resins Co.
Panelyte Div.
Penn Rivet Corp.
Philpott Rubber Co., The
Pierce Plastics, Inc.
Pittsburgh Plate Glass Co.
Plaskon Co., The
Plascraft Co.
Plastic Prod. Co.
Plastics Div. Amer. Cyna. Production Engrg. Co.
Revere Copper and Brass, Inc.
Reynolds Molded Plastics Div.
Reynolds Molded Plastics, Inc.
Richardson Co.
Rohm & Haas Co.
Sav-Way Industries
Scholl Mfg. Co., Inc., The
Searle Aero Industries, Inc.
Sign Craft Engraving Co.
Southern Friction Materials Co.
Spaulding Fibre Co.
Standard Varnish Works
Stegner, Chas. V. & Sons
Stout Research Div.
Successful Plastics Recovery Wks.
Synthane Corp.
Taylor Fibre Co.
Taylor Mfg. Co.
Technical Ply-Woods
Teckna-Plastics Co., Inc.
Tennessee Eastman Corp.
Tensolite Corp., The
Thaden Engineering Co.
Union Carbide & Carbon Corp.
U. S. Stoneware Co., The
Universal Moulded Products Corp.
Watertown Mfg. Co., The
Webb Products Co., Inc.
Werner Co., Inc., R. D.
Western Felt Works
Western Plastics Co.
Westinghouse Elect. & Mfg. Co.
Westinghouse Electric & Mfg. Co. Lima Works
Wilmington Fibre Spec. Co.
Winborne Plastics Moulding
Ziebarth Co., Fritz

67—PLASTIC PARTS

A. B. C. Products, Inc.
Acme Lumber Co.
Aero Components Mfg. Co.
Air Associates, Inc.
Allite Mfg. Company
American Aero Supply Co.
American Insulator Corp.
American Phenolic Corp.
American Radio Hardware Co.
Anchor Plastics Co.
Arnolt Motors Co.
Auburn Button Works, Inc.
Aviation Engineering, Inc.
Bakelite Corp.
Ballard Aircraft Co., Inc.
Barber-Colman Co.
Bastian Bros. Co.
Bay Mfg. Div.
Blue Jay Aeronautical Company
Bullard Co., E. D.
Burndy Eng. Co., Inc.
Capac Mfg. Co.
Carbide & Carbon Chem. Corp.
Cardinal Corporation, The
Catalin Corp.
Celanese Celluloid Corp.
Cellulose Prods. Co.
Chautauqua Swaging Co.
Chicago Molded Products Corp.
Chryson's Ltd.
Cinch Mfg. Corp.
Cole Electric Co.
Columbia Aircraft Products, Inc.
Columbian Rope Co.
Commercial Plastics Co.
Continental-Diamond Fibre Co.
Cook Engrg. Co.
Cordo Chemical Corp.
Crofut Co., Willard
Crowncraft, Inc.
Del Riccio Plastic Products
Detroit Macoid Corp.
Die Cast Corp.
Dockson Corp.
Dunne Rubber Co.
du Pont de Nemours & Co., Inc., E. I. (Plastics Dept.)
Dura Plastics, Inc.
Erie Resistor Corp.
Eveready Hardware Mfg. Co., Inc.
Extruded Plastics, Inc.
Federal Elec. Co., Inc.
Felsenthal & Sons, G.
Firestone Aircraft Co.
Firestone Rubber & Latex
Formica Insulation Co., The
Franklin Fibre-Lamitex Corp.
Gatke Corp.

The Sky's His Limit Under the Best Postwar Plan

Freedom is not given a people by a benevolent Government—it is something we must work to *get* and work to *keep*. Freedom of Enterprise has made America the world's most powerful and prosperous nation in both peace and war. Here we have the highest wages paid in the world, here we have developed the highest standard of living. Here we have not been subject to the repressions of a state-controlled economy, but have been free to develop individualism and self-reliance. Let's keep it that way.

We believe our returning soldiers will prefer a job with private industry where the "Sky Is the Limit" for their advancement—in direct proportion to their individual initiative, skill, and ability. Our system of Free Enterprise makes this possible, for it creates the vast volume of American production so necessary to attain and maintain high levels of employment.

In planning for the future, what can be more vital than to combat many plans that seek to abandon the system that has made this possible—Free Enterprise. Continuance of Free Enterprise, plus native American industrial skill and ability, will avoid the gaunt spectre of mass unemployment after the War.

But—unless we are willing to trade the time-proven Free Enterprise system for some substitute which will nullify individual initiative, progress, and freedom, we must speak up. We must explain its principles and advantages to those who may not understand them, because appreciation comes only from knowledge and understanding. If we fail to do this, the failure will be ours.

CURTIS

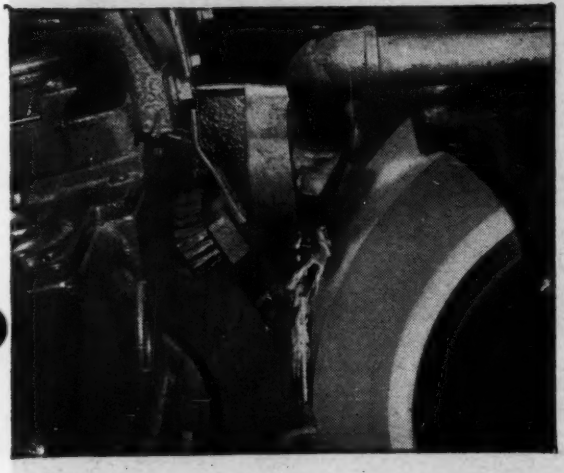
CURTIS PNEUMATIC MACHINERY DIVISION
of Curtis Manufacturing Company
1957 Kienlen Avenue St. Louis, Mo.
Air Compressors • Air Hoists • Air Cylinders

CUTTING TOOL TIPS FROM THE TOP-NOTCHERS

"In Precision Grinding make certain the wheel fits the operation"

says C. E. QUAY, General Mgr.
OHIO TOOL COMPANY
Cleveland, Ohio

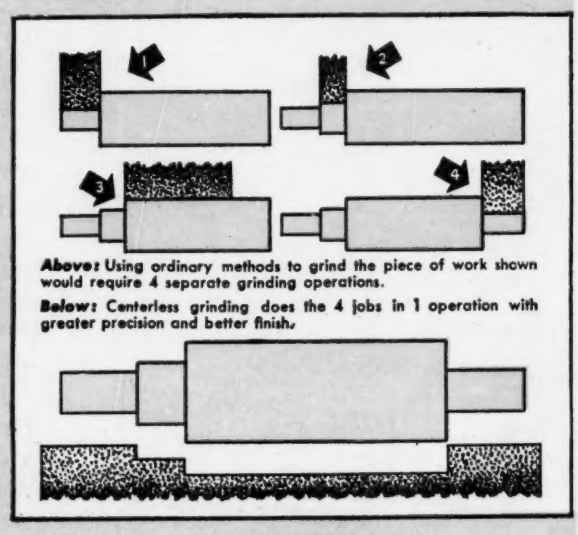
Ohio Tool Company, engaged 100% in war work, is today one of the largest manufacturers of small arms ammunition tools. This accomplishment has been made possible by the development of new methods and equipment, which, in turn, have resulted in a higher rate of production at lower cost.



"TO use a different wheel for every grinding operation in the plant would be a highly impractical and costly proposition. On the other hand, using too few wheels to do a multiple number of jobs sacrifices accuracy and speed of production; requires more manual handling.

"The answer to this problem is profile or centerless grinding . . . a development that grew from the unprecedented production demands of World War II. Precision profile grinding, for example, has made it possible to finish small arms ammunition tools, principally punches, on a production basis. Previously they had been ground singly or a few at a time on conventional tool-room grinding equipment. Internal grinding to finishes of 2 to 4 micro inches is not uncommon on small arms ammunition tools.

"As the sketches below indicate, the ability to centerless-grind several diameters, including tapers, radii, profiles, etc., simultaneously, has reduced what formerly required several operations, to one. In this way, less equipment is needed to produce larger quantities of more uniform tools, releasing additional equipment for other war necessities."



Above: Using ordinary methods to grind the piece of work shown would require 4 separate grinding operations.

Below: Centerless grinding does the 4 jobs in 1 operation with greater precision and better finish.

The proper selection of grinding oils is as important as the selection of the correct grinding wheel. That's why Shell Lubrication Engineers have developed a control technique that "tailor-makes" the oil to fit the machine, the application, and the tool. Ask the Shell man for the details.

SHELL CUTTING OILS

FOR METAL CUTTING AND GRINDING

SHELL

Gemloid Corp.
General Electric Co. (Plastics)
Gibson, Inc.
Goodyear Tire & Rubber Co., Inc.
Hagedorn Engineering
Hammond Inst. Co.
Hawley Prods. Co.
Hayes Mfg. Corp.
Heath Co.
Heinz Co., H. J.
Holdenline Co.
Holfast Rubber Co., The
Huntington Rubber Mills
Hydropack
Industrial Synthetics Corp.
Inland Mfg. Div.
Insulating Fabricators, Inc.
Kellogg Switchboard & Supply
King Plastics Corp.
Kerr Co., R. W.
Keyes Fibre Co.
King Plastics Corp.
Kirby Co., The
Kirk Plastic Corp.
Krehbiel Plastic Products
Kulka Elec. Mfg. Co., Inc.
Kurz-Kasch, Inc., The
Lacey-Weber Co.
Langley-Mills Aircraft Corp.
McDonnell Aircraft Corp.
McInerney Plastics Co.
McQuay, Inc.
Mack Molding Co.
Manufacturers Chemical Corp.
Metal Specialty Co., The
Miller Dial & Name Plate Co.
Molded Insulation Co.
Monsanto Chemical Co., Plastics
Morrow Aircraft Co.
National Lock Co.
New England Tape Co., Inc.
New Plastic Corp.
Nixon Nitration Wks.
Northern Industrial Chemical Co.
Panelyte Div.
Parker Stamp Wks., Inc., The
Paramount Rubber Co.
Pennsylvania Plastics Corp.
Pernot & Rich, Inc.
Pierce Plastics, Inc.
Pittsburgh Plate Glass Co.
Plascraft Co.
Plastic & Die Cast Products Corp.
Plastic & Rubber Products Co.
Plastic Manufacturers, Inc.
Plastic Prod. Co.
Plastics Moulding Corp.
Pixweve Mfg. Co.
Plymold Corp.
Precision Fabricators, Inc.
Printloid, Inc.
Production Engrg. Co.
Reisner & Co., The, W. H.
Remler Co., Ltd.
Resistoflex Corp.
Reynolds Molded Plastics, Div.
Richardson Co.
Ridgefield Mfg. Corp.
Ritter Co., Inc.
Robins Co., J. R.
Rohm & Haas Co.
Sav-Way Industries
Scholl Mfg., Inc., The
Sign Craft Engraving Co.
Snapvent Co.
Snow-Craggs Corp.
Spalding & Bros., A. G.
Spaulding Fibre Co.
Spier Aircraft Corp.
Standard Molding Corp.
Standard Products Co., The
Stanley Mfg. Co., The
Stegner, Chas. V. & Sons
Stokes Rubber Co., Joseph
Stout Research Div.
Strickler Brunhuber Co.
Success Plastics Recovery Wks.
Synthane Corp.
Taylor Fibre Co.
Taylor Mfg. Co.
Technical Plastics Co.
Technical Ply-Woods
Teckna-Plastic Co., Inc.
Thaden Engineering Co.
U. S. Propellers, Inc.
U. S. Stoneware Co., The
Universal Moulded Products
Varflex Corp.
Vidal Research Corp.
Virginia Lincoln Corp.
Vichek Tool Co.
Voges Mfg. Co., The
Ward Plastics & Rubber Co.
Waterbury Button Co.
Watertown Manufacturing Co.
Weatherhead Co., The
Werner Co., Inc., R. D.
West Branch Novelty Co.
Westcraft, Inc.
Western Felt Works
Western Lithograph Co.
Westinghouse Elect. & Mfg. Co.
Westinghouse Electric & Mfg. Co. Lima Works
Whitehead Metals Prod. Co.
Wilmington Fibre Spec. Co.
Winborne Plastics Moulding
Ziebarth Co., Fritz

68—PLATING, METALLIZING, ANODIZING, GALVANIZING, ETC.

Acme Plating Co.
Acme Steel & Malleable Iron
Adel Precision Products Corp.
Agerstrand Corp.
Aircraft Bolt & Rivet Co.
Aircraft Plating Co.
Airplane & Marine Instruments
American Nickeloid Co.
American Solder & Flux Co.
Arnolt Motor Co.
Aro Equipment Corp.
Arrow Plating Co., The
Auld Co., The, D. L.
Aviation Engineering, Inc.
Aviation Parts, Inc.
Brubaker Polishing & Plating
Cadmium & Nickel Plating Co.
Chicago Hardware Foundry Co.
Chicago Thrift Co.
Chromium Corp. of America
Chromium Roll and Machine Co.
Colonial Alloys Co.
Commonwealth Industries, Inc.
Consolidated Equip., Inc.
Cowan Mfg. Co.
Crowe Name Plate & Mfg. Co.
Deagen, Inc., J. C.
Dearborn Chemical Co.
Dockson Corp.
Driscoll & Co.
E F G Engineering Works, Inc.
Edo Aircraft Corp.
Electric Products Co.
Electric Sprayit Co., The
Electro Chrome Co.
Electro Plastic Processes
Engineering Development Assoc.
Eveready Hardware Mfg. Co., Inc.
Flour City Ornamental Iron Co.
Glidden Buick Corp.
Goodyear Aircraft Corp.
Guarantee Specialty Mfg. Co.
Hall Lamp Co., C. M.
Handy & Harman
Hanson-Van Winkle-Munning
Hard Chrome Eng. Co.
Hayes Mfg. Corp.
Himmel Bros. Co., The
Hobart Bros. Co.
Induim Corp.
Industrial Washing Mach. Corp.
Kelite Prod., Inc.
Keystone Chromium Corp.
Kliegl Bros.
Knape & Vogt Mfg. Co.
Koven & Brothers, Inc., L. O.
Lasalco, Inc.
L'Hommedieu & Sons Co., Chas.
Liberty Aircraft Products Corp.
Livingston Machine Shop
Los Angeles Heavy Hardware Co.
Los Angeles Plating Co.
Martin-Parry Corp.
Mefford Chemical Co.
Memphis War Industries, Inc.
Metal Finishing Co., The
Metallizing Co. of America
Metallizing Engrg. Co., Inc.
Mercil & Sons Plating Co., B.
Midwest Engrg. & Tool Co.
Miller Co., J. C.
Modern Plating Co.
Monarch Metal Weatherstripp. Co.
Moss & Co., Henry
Munning & Munning, Inc.
National Radiator Co., The
National Telephone Supply Co.
Nelson & Horrat Plating Wks.
Northern Engraving & Mfg. Co.
Oakes & Burger Co.
Pacific Car & Foundry Co.
Parker Wolverine Co.
Paxton-Mitchell Co.
Pennsylvania Salt Mfg. Co.
Philadelphia Rust-Proof Co.
Plastic Prod. Co.
Q. R. S. Neon Corp., Ltd.
Reynolds Metals Co.
Reynolds-Robson Supply Co., The
Rheem Mfg. Co.
Ritter & Co., Inc.
Rising, H. G.
Roeper Co., R. H.
Ross Galvanizing Works
Schori Process Corp.
Simmons Plating Wks.
Skylark Mfg. Co., Inc.
Southern Cal. Plating Co.
Sterling Electric Co.
Stevens, Inc., Fred. B.
Strickland Aircraft Corp., The
Turco Prods., Inc.
Udylite Corp.
Universal Bldg. Prods. Corp.
Utility Fan Corp.
Van der Horst Corp. of America
Western Mfg. Supply Co.
White Engineering Co.
Witt Cornice Co., The
Woodworth Co., N. A.
York Safe & Lock Co.

69—PLUGS—ELECTRICAL CONNECTING

Aerial Mach. & Tool Corp.
Airadio, Inc.
American Radio Hardware Co.
Appleton Electric Co.
Automatic Electric Co.
Boes Co., The W. W.
Cannon Elec. Development Co.
Cole-Hersee Co.
Corning Glass Works
Domestic Mfg. Co.
Eclipse Pioneer Div.
Federal Elec. Co., Inc.
Freeport Machine Works, Inc.
Garfield Electrical Supply Co.
Hagedorn Engrg.
Harwood Co., The
Hopax Devices, Inc.
Hubbell, Inc., Harvey
Jones, Howard B.
Kellogg Switchboard & Supply
Kenyon Instrument Co.
Kirkhill Rubber Co.
Kliegl Bros.
Kulka Elec. Mfg. Co., Inc.
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Peterson, F. Somers Co.
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Pollak Mfg. Co.
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Remler Co., Ltd.
Rusgreen Mfg. Co.
St. Louis Engineering Co.
Schuck Mfg. Co.
Searle Aero Industries, Inc.
Thomas & Betts Co.
Turtle & Hughes, Inc.
Western Mfg. Supply Co.
Westinghouse Electric & Mfg. Co. Lima Wks.

70—PLYWOOD & VENEERS

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Aero Services, Inc.
Aeronautical Trading Co.
Aetna Plywood & Veneer Co.
Allied Aviation Corp.
Allied Veneer & Lumber Co.
American Plywood Corp.
Andover Kent Aviation Corp.
Appleton & Co., Inc.
Blue Jay Aeronautical Company
Bonneau Co., J. J.
Burnside Veneer Co., Inc.
California Panel & Veneer
Crescent Panel Co.
Cross, Austin & Ireland Lumber
Davis Plywood Corp.
Eggers Plywood & Veneer
Evans Products Co.
Fessenden Hall
Fletcher Aviation Corp.
General Veneer Mfg. Co.
Goshen Veneer Co.
Harbor Plywood Corp.
Hardman Peck & Co.
Hoosier Panel Co., The
Indiana Veneer & Panel Co.
Jamestown Veneer & Plywood Corp.
Jasper Wood Prods. Co., Inc.
Lane Co., Inc., The
Mansion House Furniture Co.
Marine Air Research Corp.
Mengel Co., The
Morrow Aircraft Co.
National Aircraft Materials Corp.
Nickey Bros., Inc.
Omaha Hardwood Lumber Co.
Reliable Mach. Shop
Rheem Mfg. Co.
Roberts-Dulaney Veneer Corp.
Roddis Lumber & Veneer Co.
Skydyne, Inc.
Sloane W. & J.
Stegner, Chas. V. & Sons
Strickland Aircraft Corp., The
Summit Ind. Prod. Co.
Technical Ply-Woods
Thaden Engineering Co.
U. S. Plywood Corp.
U. S. Rubber Co.
Universal Moulded Products Corp.
Virginia Lincoln Corp.
White Bros.
Ziebarth Co., Fritz

71—PLYWOOD PARTS

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Algoma Plywood & Veneer Co.
Allied Aviation Corp.
American Aviation Corp.
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Auld Co., The D. L.
Ault & Weborg Corp.
Aviation Engineering, Inc.
Baker Furniture, Inc.
Ballard Aircraft Co., Inc.
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Birds Eye Veneer Co.
Blue Jay Aeronautical Company
Burnside Veneer Co., Inc.
Burton-Rodgers, Inc.
California Panel & Veneer Co.
Charles Mfg. Co.
Cook Engrg. Co.
Crescent Panel Co.
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Deagen, Inc., J. C.
Del-Air Corp.
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Evans Products Co.
Fahlin Mfg. Co.
Fletcher Aviation Corp.
Fogel Refrigerator Co.
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Goshen Veneer Co.
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Haskelite Mfg. Corp.
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Krehbiel Plastic Products
Kilgen Aircraft Div.
Klassen Co., The
Lane Co., Inc., The
Langley-Mills Aircraft Corp.
Lester Industries, Inc.
Lights, Inc.
Lorenzen Industries
Mansion House Furniture Co.
Marine Air Research Corp.
McKee Door Co.
McLaurin Jones Co.
McQuay, Inc.
Mengel Co., The
Meyers Aircraft Co.
Morrow Aircraft Co.
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Nichols & Cox Lumber Co.
Nickey Brothers, Inc.
Olympic Mfg. Corp.
P-V Engineering Forum, Inc.
Panelyte Div.
Pearl City Plywood Co., Inc.
Pike Dial Lumber Co.
Pluswood Inc.
Pixweve Mfg. Co.
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Pulaski Veneer Corp.
Ridgefield Mfg. Corp.
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Spalding Bros., A. G.
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Stenger, Chas. V. & Sons
Story & Clark Piano Co.
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Strombeck-Beeker Mfg. Co.
Taylorcraft Avia. Corp.
Technical Ply-Woods
Thaden Engineering Co.
Timm Aircraft Corp.
U. S. Plywood Corp.
U. S. Propellers, Inc.
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72—PROPELLERS & PARTS

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Aircraftsmen Co., The
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American Propeller Corp.
American Rolling Mill Co., The
American Smelting & Refining
Ampco Metal, Inc.
Aro Equipment Corp.
Atlantic Diesel Corp.
Bartlett Hayward Div., Koppers
Borg Warner Corp.
Burris of Essex County, Inc.
California Propeller Co.
Camfield Mfg. Co.
Chicago-Wilcox Mfg. Co.
Columbia Aircraft Products, Inc.
Curtiss-Wright Corp.
Detroit Gear Aircraft Parts Div.
Die Cast Corp.
Engineering & Research Corp.
Everel Propeller Corp., Div.
Fahlin Mfg. Co.
Fidelity Elec. Co.
Flottorp Propeller Co.
Formica Insulation Co., The
Freedman-Burnham Engrg. Corp.
Frigidaire Div.
Gardner Propeller Co.
General Electric Co.
Gwinn-Stone, Inc.
Hamilton Standard Propellers
Hardman Peck & Co.
Hartzell Propeller Co.
Hi Standard Mfg. Corp.
Industrial Washing Mach. Corp.
Joyce Aviation, Inc.
LaLance & Grosjean Mfg. Co.
Lewis Co., G. B.
Liss Aircraft Prods. Co.
Lorenzen Industries
McCauley Steel Propeller Co.
Marquette Metal Prods. Co., The
Mechanical Products, Inc.
Models, Inc.
Nash-Kelvinator Corp.
Northwest Air Service, Inc.
Northern Aircraft Prods. Div.
Panelyte Div.
Pilot Propellers, Inc.
Precision Products, Inc.
Reliable Spring & Wire Forms
Remington Rand, Inc.
Republic Aircraft Products Div.
Riehle Machine Co.
Rolls-Royce, Inc.
Sensenich Brothers
Smith Corp., A. O.
Special Mach. Tool Engrg. Wks.
Sponge Rubber Products, Co.
Steel Products Engrg. Co., The
Stone Propeller Co.
Story, Gawley Co.
Taft Peirce Mfg. Co.
Taylor Machine Co., The
Thompson Products, Inc.
Transcontinental Machine & Tool
Trayer Aircraft
Tubular Alloy Steel Corp.
Tyer Rubber Co.
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Universal Aircraft Co.
Variety Aircraft Corp., The
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Wetzler Clamp Co., The
Wheeling Bronze Casting Co.
Wickwire Spencer Aviation Corp.
Wiggins Airways, Inc., E. W.
Wiley, Inc., R. & W.

72(a)—PROTECTIVE WRAPPINGS AND DESSICANTS

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Celanese Celluloid
Criterion Paper & Twine Co.
Davison Chemical Corp., The
Package Machinery Co.
Permutit Co., The

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American Radio Hardware Co.,
Aviation Engineering, Inc.
Ballard Aircraft Co., Inc.
Bickford & Francis Belting Co.
Chain Belt Co.
Christiana Machine Co.
Crofut Co., Willard
Formica Insulation Co., The
General Aviation Equip. Co., Inc.
King Plastics Corp.
Kirby Co., The
Livingston Machine Shop
McInerney Plastics Co.
Memphis War Industries, Inc.
Molded Insulation Co.
New Plastic Corp.
Panelyte Div.
Plastic Manufacturers, Inc.
Plastic Prod. Co.
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Tammany Mach. Shop.
Teckna-Plastic Co., Inc.
Wash. Iron Wks.
Westinghouse Elec. & Mfg. Co.
Westinghouse Elec. & Mfg. Co. Lima Wks.
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74—RADIATORS

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Aircraft Steel & Supply Co., The
Airesearch Mfg. Co.
Borg Warner Corp.
Busser Supply Co.
Clifford Mfg. Co.
Drayer & Hanson, Inc.
Fedders Mfg., Inc.
G & O Mfg. Co.
Garrett Corp., The
Gray-Mills Co.
Harrison Radiator Div.
Hopewood Mfg. Co.
McCord Radiator &. Mfg. Co.
McQuay, Inc.
Modine Mfg. Co.
Rome-Turney Radiator Co.
Speedometer Service & Accessories
United Aircraft Products, Inc.
Tropic-Aire, Inc.
Utility Fan Corp.
Winchester Repeating Arms Co.
Yates-American Machine Co.
Young Radiator Co.

74a—RADIO & RADIO EQUIPMENT see 16

75—RESEARCH—EXPERIMENTAL & SPECIAL SERVICES

Abrams Instrument Corp.
Acrotorque Co., The
Adel Precision Products Corp.
Aero Engineering, Inc.
Aero Research Wind Tunnel Co.
Aero Supply Mfg. Co., Inc.
Air Cruisers, Inc.
Aircraft Development Co.
Aircraft Production Corp.
Airesearch Mfg. Co.
Airex Mfg. Co.
Airplane Mfg. & Supply Corp.
Allied Aviation Corp.
American Aircraft Associates
American Instrument Co.
American Screw Products
American Time Products, Inc.
Andrews Laboratories, W. F.
Aro Equipment Corp.
Atlas Tool & Designing Co.
Austin Co., The
Airadio, Inc.
Aircraft Development Co.
Airex Mfg. Co.
American Aviation Corp.
Austin Co., The
Automatic Electrical Devices Co.
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Aviation Engineering, Inc.
Aviometer Corp.
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Babb Co., Chas. H.
Ballantine Laboratories, Inc.
Barnes Corp., John S.
Baugh Bros. & Co.
Bell & Howell Co.
Black Bear Co., Inc.
Borg Warner Corp.
Burton-Rodgers, Inc.
Carll Sons, C. W.
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Connecticut Hard Rubber Co.
Continental Aviation & Engrg. Corp.
Cook Engrg. Co.
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Curtiss-Wright Corp., Devel. Div.
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Hole Engr. Service
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Kenyon Instrument Co.
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Kulka Elec. Mfg. Co., Inc.
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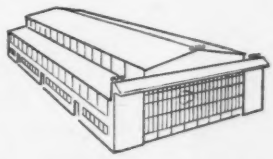

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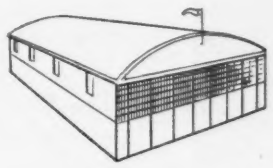

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Westinghouse Air Brake Co.
Westinghouse Elec. & Mfg. Co.
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Withrow Co., Arthur C.
York Corp.
York Safe & Lock Co.
Zamax Mfg. Co.

76—RIVETS

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Moss & Co., Henry
National Rivet & Mfg. Co.
Neal Co., Inc., R. C.
New England Screw Co.
Pacific Moulded Products Co.
Pacific Railway Equip. Co.
Penn Rivet Corp.
Pitkin Mach. Wks.
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Tull Metal & Supply Co., J. M.
U. S. Steel Supply Co.
Whitehead Metal Prod. Co.

77—RUBBER & SYNTHETICS

Adel Precision Products Corp.
Air Cruisers, Inc.
American Cellulose Co.
American Rubber Mfg. Co.
American Tire Machy. Co.
Armstrong Cork Co.
Atlantic India Rubber Works
Automotive Rubber Co.
Backstay Welt Co.
Bettis Rubber Co.
Borg Warner Corp.
Bowling Green Rubber Co.
Brown Rubber Co., Inc.
Burlington Mills, Inc.
Buffalo Weaving & Belting Co.
Canfield Co., The H. O.
Carbide & Carbon Chem. Corp.
Chardon Rubber Co., The
Connecticut Hard Rubber Co.
Continental Rubber Wks.
Corduroy Rubber Co.
Dayton Rubber Mfg. Co., The
Dockson Corp.
Dunne Rubber Co.
du Pont de Nemours & Co., Inc., E. I. (Wilmington)
Dural Rubber Co.
Elmhurst Rubber Co., Inc.
Fabreeka Products Co.
Felt Products Mfg. Co.
Firestone Aircraft Co.
Firestone Rubber & Latex Prods.
Gardner Co., J. R.
Garlock Packing Co., The
Gasket Shop, The
Gates Rubber Co.
General Finishes, Inc.
General Tire & Rubber Co., The
Golden State Rubber Mills
Goodall Rubber Co.
Goodrich Co., The B. F.
Goodyear Tire & Rubber Co., Inc.
Gordon-Lacey Chem. Prods. Co.
Goshen Rubber & Mfg. Co.
Graton & Knight Co.
Hercules Equip. & Rubber Co.
Hewitt Rubber Corp., Aircraft Div.
Holfast Rubber Co., The
Horn Co., A. C.
Huntington Rubber Mills
Hycar Chem. Co.
Hydropack
Ideal Roller & Mfg. Co.
Industrial Supply Co., Inc.
Industrial Synthetics Corp.
Inland Mfg. Div. General Motors
Johnson Rubber Co., The
Kite Aircraft Corp.
L. A. Rubber & Abestos Works
Linear Packing & Rubber Co.
Manhattan Rubber Mfg. Div.
Marathon Rubber Prods. Co.
Martin Rubber Co., Inc.
McInerney Plastics Co.
Meirath Supply & Gasket Co.
Miller Products Co., Inc.
Miller Rubber Co.
Monarch Rubber Co., The
New England Tape Co., Inc.
Ohio Rubber Co.
Pacific Moulded Products Co.
Paramount Rubber Co.
Penn Elastic Co.
Philpott Rubber Co., The
Phoenix Mfg. Co.
Pioneer Rubber Mills
Plascraft Co.
Plastic & Rubber Products Co.
Premier Rubber Mfg. Co., The
Prince Rubber Co., Inc.
Quaker Rubber Corp.
Raybestos-Manhattan, Inc.
Republic Rubber Div.
Resinous Prods. & Chemical Co.
Resistoflex Corp.
Reuther Equip. & Paint Co.
Rodic Rubber Corp.
Rubbercraft Corp. of Cal.
Scholl Mfg. Co., Inc., The
Seidlitz Paint & Varnish Co.
Sierra Rubber Co.
Spalding & Bros., A. G.
Sponge Rubber Products Co.
Standard Products Co., The
Stenger, Chas. V. & Sons
Stone, Harry E. Rubber Co.
Success Plastics Recovery Wks.
Summit Ind. Prod. Co.
Sun Rubber Co., The
Taylor Mfg. Co.
Technical Coatings, Inc.
Thiokol Corp.
Tingley-Reliance Rubber Corp.
Toledo Industrial Rubber Co.
Tull Metal & Supply Co., J. M.
Tyer Rubber Co.
U. S. Rubber Co.
U. S. Steel Supply Co.
U. S. Stoneware Co., The
Virginia Rubatex Div.
Volt Rubber Co.
Vulcan Proofing Co.
West American Rubber Co.
Western Felt Works
Wolverine Fabricating & Mfg.

77a—SCREWS, see 30

78—SEAT BELTS

Aerial Mach. & Tool Corp.
Aeronautical Trading Co.
Airchox Co., Div. Joyce Avia.
Aircraft Appliance Corp.
Air Parts, Inc.
American Aero Supply Co.
Brandwein & Co., A.
Buffalo Weaving & Belting Co.
Bullard Co., E. D.
Firestone Aircraft Co.
Georgia Webbing & Tape Co.
Hagerstown Leather Co., The
Parachute Corp. of American, Potter, Inc., L.
Russell Mfg. Co., The
Saunders & Associates, Geo. F.
Schlegel Mfg. Co., The
Security Parachute & Equipment
Sullivan & Sons Co., Inc., J.
Switlik Para. Co.
Thermoid Co.
U. S. Rubber Co.
Zip-A-Bag Corp.

79—SEATS & SEATING MATERIALS

Aircraft Development Co.
American Aviation Corp.
American Leather Prods. Co.
American Seating Co.
Anderson Flax Fiber Co., Inc.
Angle Steel Stool Co.
Applegate Amphibians
Aviation Engineering, Inc.
Ballard Aircraft Co., Inc.
Bendix Products Div.
Berkey & Gay Furniture Co.
Blanchard Bros. & Lane
Blocksom & Co.
Brill Co., The J. G.
Budd Mfg. Co., Edward G.
Charles Mfg. Co.
Chicago Hardware Foundry Co.
Chicago Hardware Foundry Co.
Clarin Mfg. Co.
Cleveland Tanning Co.
Colson Corp.
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Craftex Mills, Inc. of Pa.
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Weber Showcase & Fixture Co.
Wilber & Son
Woll & Co., F. P.
Ziebarth Co., Fritz

79a—SERVICES, Special see 75

80—SHOP EQUIPMENT: MACHINE TOOLS

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Abrasive Company
Abrasive Machine Tool Co.
Acme Machinery Div.
Acromark Co., The
Acrotorque Co., The
Advance Aircraft Tool Co.
Aerco Corp.
Aero Tool Co.
Aeronautical Machinists
Aeronautical Mfg. Corp.
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Air Reduction Sales Co.
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Aircraft Tool Co.
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Alfa Mach. Co., Inc.
Allegheny Ludlum Steel Corp.
Alloys Foundry, Inc.
Almquist Bros. & Viets
Alofs Mfg. Co.
Alto Mfg. Co.
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American Chain & Cable Co.
American Gauge Co., The
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American Screw Products
American Turbotor Corp.
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Andrews & Perillo Mfg. Corp.
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Arter Grinding Machine Co.
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Auto-Soler Company
Automotive Maintenance Machy.
Avery Drilling Machine Co., The

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Baker-Spiegel Co.
Bakewell Mfg. Co.
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Baldwin Locomotive Wks.
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Barnes Drill Co.
Barrett Equipment Co.
Bath Co., The Cyril
Bausch Machine Tool Co.
Bay State Prods. Co.
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Bernitz, Inc., J. I.
Beverly Grinding Service
Bird Aircraft Products
Birdsboro Steel Fdry. & Mach.
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Black Drill Co.
Blacker Engrg. Co.
Blackhawk Mfg. Co.
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Blanchard Mach. Co., The
Bliss Co., E. W.
Blum & Co., Inc., Julius
Boice Crane Co.
Bokum Tool Co.
Boyar-Schulz Corp.
Bradford Machine Tool Co., The
Brand Tool & Supply Co.
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Buffalo Forge Co.
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Cincinnati Gilbert Machine Tool
Cincinnati Lathe & Tool Co., The
Cincinnati Milling & Grinding Machines, Inc.
Cincinnati Planer Co., The
Cincinnati Shaper Co.
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Clark Electric Co., Jas., Jr.
Clausing Mfg. Co.
Clearing Mach. Corp.
Clemson Bros., Inc.
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Cleveland Automatic Mach. Co.
Cleveland Planer, The
Cleveland Pneumatic Tool Co.
Cleveland Punch & Shear Wks.
Cleveland Tool Engrg. Co., The
Coast Tool & Engrg. Wks.
Columbia Machy. & Engineering
Commerce Patern Fdry.
Commonwealth Aircraft, Inc.
Cone Automatic Machine Co., Inc.
Consolidated Machine Tool Corp.
Continental Machines, Inc.
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Coulter Machine Co., The James
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Dumore Co.
Dunbar Kapple, Inc.
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Ex-cell-O Corp.
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Farquhar Co., A. B.
Farrel-Birmingham Co., Inc.
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Fellows Gear Shaper Co., The
Fernholtz Machinery Co.
Ferracute Mach. Co.
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Gallien, R. P.
Gardner Mach. Co.
Garrison Mach. Wks., Inc.
Gear Grinding Mach. Co., The
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General Mfg. Co.
Genesee Mfg. Co., Inc.
Genesee Tool Co.
Gibbs & Co.
Giddings & Lewis Mach. Tool Co.
Gisholt Machine Co.
Gleason Works
Glenzer Company, The, J. C.
Gorham Tool Co.
Gorton Mach. Co., George
Gould & Eberhardt, Inc.
Grand Specialties Co.
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Greenfield Tap & Die Corp.
Greenlee Bros. & Co.
Grob Bros.

H & H Research Co.
Hall Co., Gordon L.
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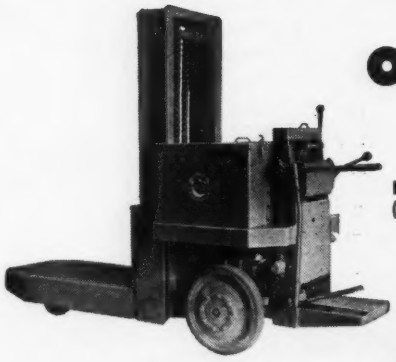
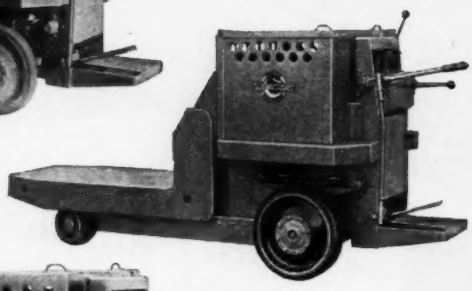


NCRE—High Lift or Tiering Truck. (4,000 and 6,000 lbs. capacity.)



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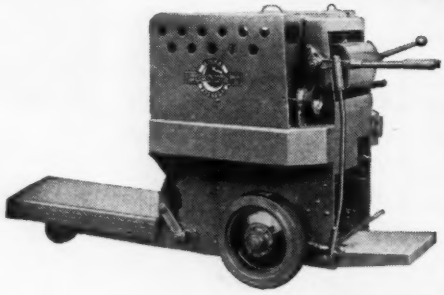
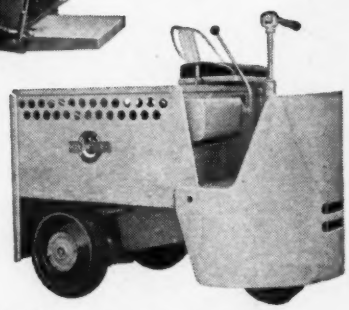


LO-LIF-TOER (LDLF)—Foot Lift Elevating Platform Truck. 3,000 lbs. capacity.



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Parker Stamp Wks., Inc., The
McDerrott Co., Patrick
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Pedrick Tool & Mach. Co.
Peerless Mach. Co.
Penn Elastic Co.
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Service Machine Co.
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Sheffield Gage Corp., The
Sheridan Co., T. W. & C. B.
Shields, Harper & Co.
Sibley Mach. & Fdry.
Simmonds Machine Tool Corp.
Skilsaw, Inc.
Skylark Mfg. Co., Inc.
Slocomb Co., J. T.
Smith-Courtney Co.
South Bend Lathe Works
Southern Cal. Plating Co.
Southern Engrg. Co., Inc.
Southern Oxygen Co., Inc.
Sparkes Mfg. Co.
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Standard Electrical Tool Co., The
Standard Machy. Co.
Standard Tool Co., The
Stanley Wks., The
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Stegner, Chas. V. & Sons
Sterling Electric Co.
Stevens Inc., Fred B.
Stokes Industries
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Stow Mfg. Co., Inc.
Strickland Aircraft Corp., The
Strippit Corp., The
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Sundstrand Mach. Tool Co.
Sunnen Prod. Co.

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Taft Peirce Mfg. Co.
Tal's Prestal Bender, Inc.
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Taylor Mfg. Co.
Techtman Industries
Thompson Grinder Co.
Tietzmann Engrg. Co.
Togstad Co., The C. I.
Toledo Standard Commutator Co.
Tool Service Co.
Tungsten Carbide Tool Co.
Turtle & Hughes, Inc.

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Walls Sales Corp.
Ward Machinery Co.
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White Aircraft Corp.
Whitman & Barnes Div.
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Wicaco Machine Corp., The
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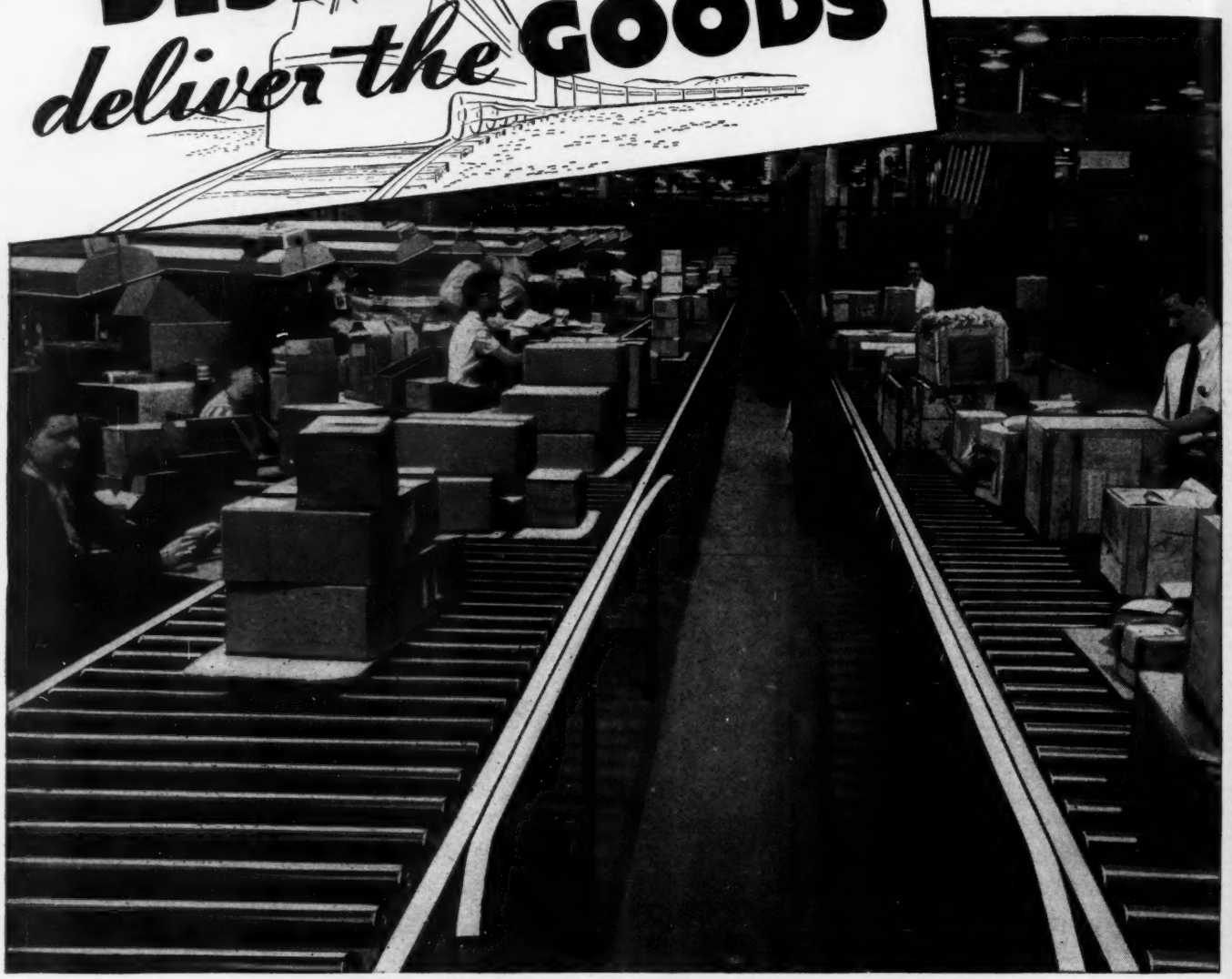

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Aircraft Engineering, inc.
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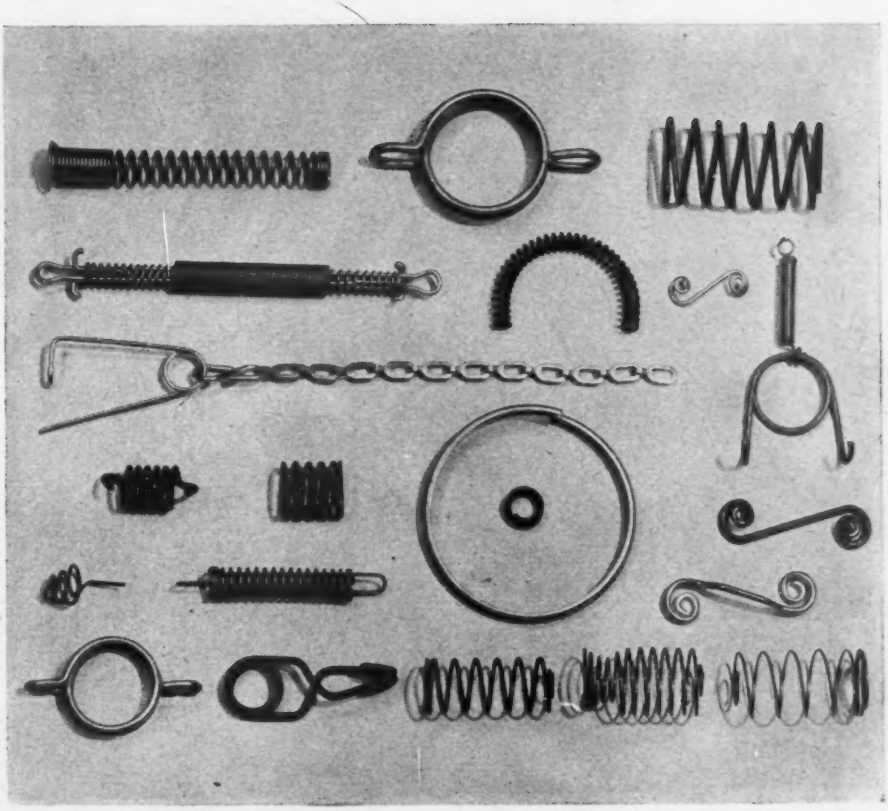

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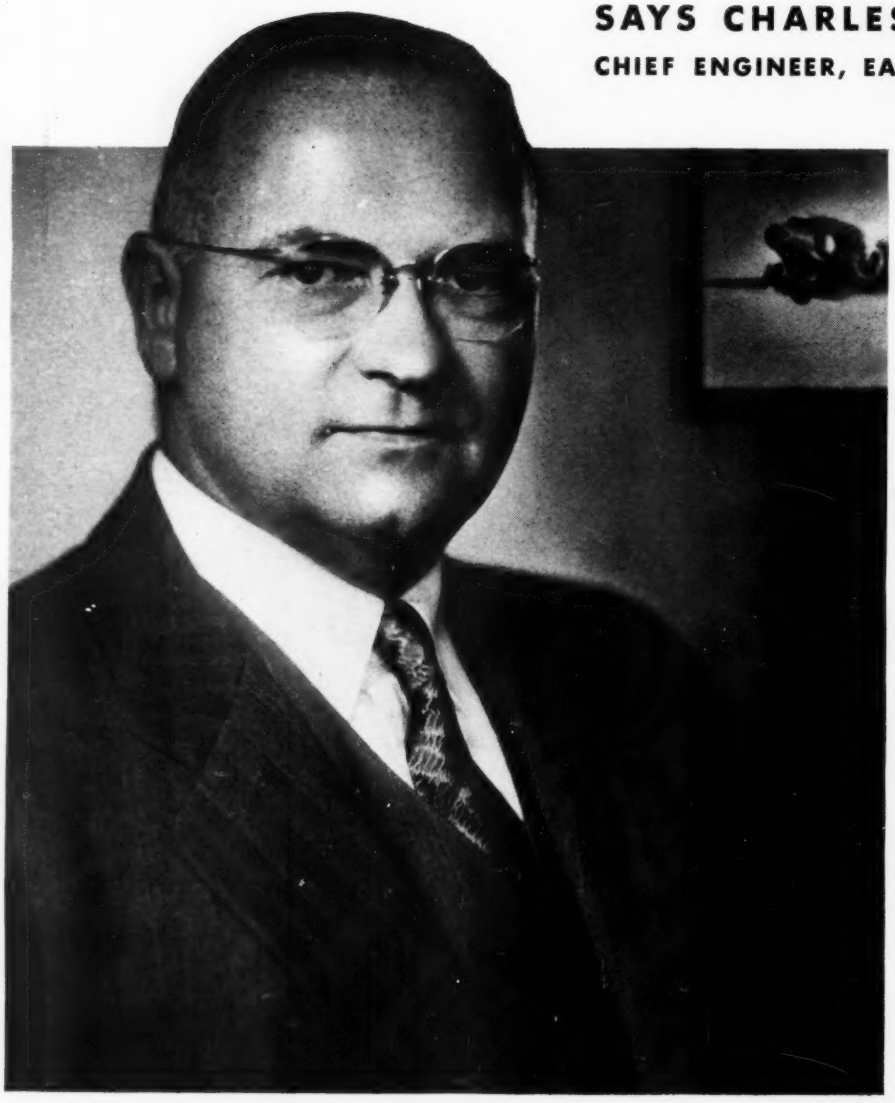

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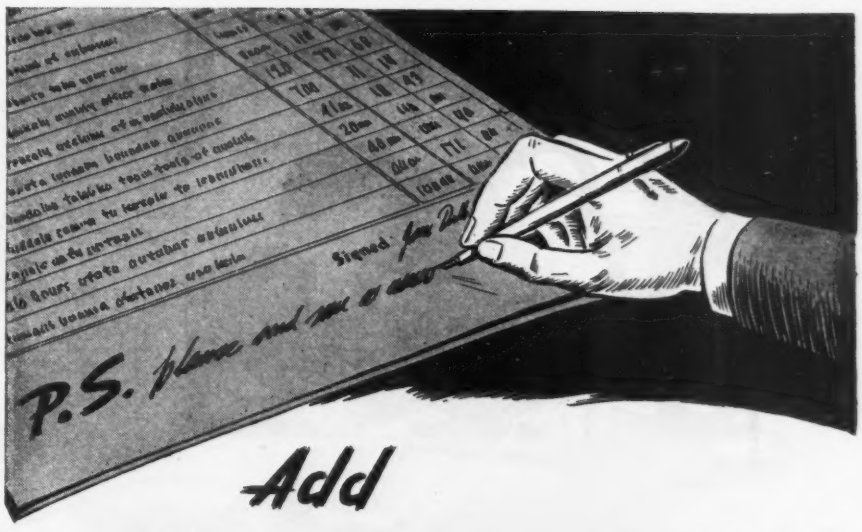

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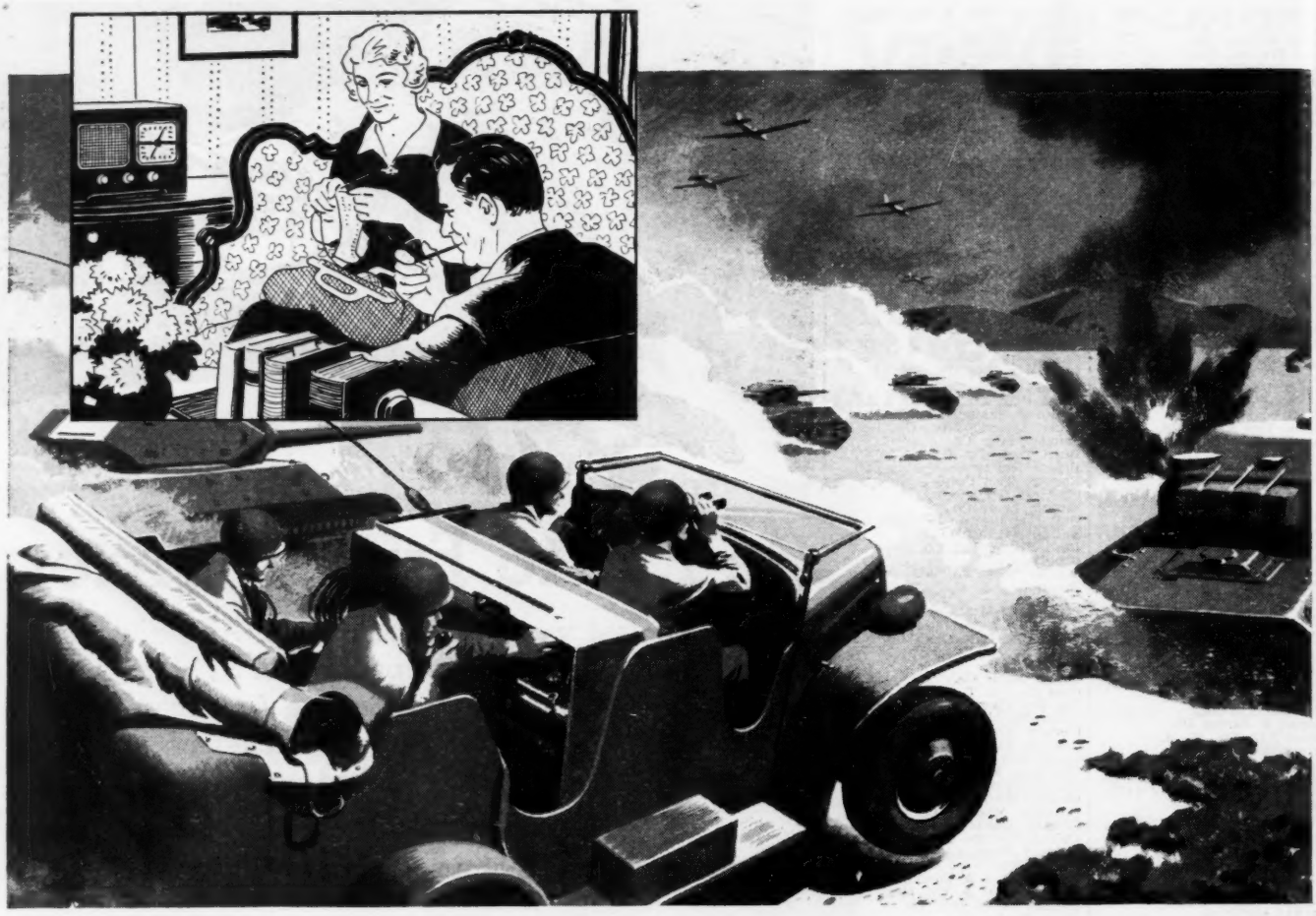

Fireside to Firing Line

It's a long way from fireside to firing line. Especially long for a radio set. For when you take this coddled precision instrument away from the peace and calm of a living room and stick it in a mobile unit at the front, you're really putting it "on the spot." Jolts, jars, concussions and extremes of temperature are the common lot of radio and electronic equipment in military service.

Fortunately, this transition was not as abrupt as it might have been, for Delco Radio technicians had tackled and solved similar problems in making automobile radios practicable. Vibration and shock . . . heat and humidity variations . . . electrical interference . . . shaking and bumping—all these obstacles were overcome one by one through the ceaseless experimentation and research of radio scientists.

With the conquest of the foes of *radio in transit* came far greater benefits than better entertainment. Years ahead of the second World War, the Delco Radio Division had solved many of the problems which inter-vehicular military radio would face. Years ahead of time, the "spirit of perfectionism" had prepared vehicular radio for its vital role at the battlefront.

Let's All Back The Attack!

BUY WAR BONDS

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Fellows Tool Co.
Fellows Gear Shaper Co., The
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Flexible Shaft Co. of New York
Florida Sponge & Chamois Co.
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Fornaciari, Bert B.
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Foundry Equipment Co., The
Frankle Co., Joseph E.
Fray Mach. Tool Co.
Frick-Gallagher Mfg. Co.
Frostrode Prods.

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Gairing Tool Co.
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Gardner-Denver Co.
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Gilmer Co., L. H.
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Hall Mfg. Co., The
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Heller Co., The
Hendey Machine Co., The
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Herold Mfg. Co., The
Hettrick Mfg. Co., The
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Hexacon Electric Co.
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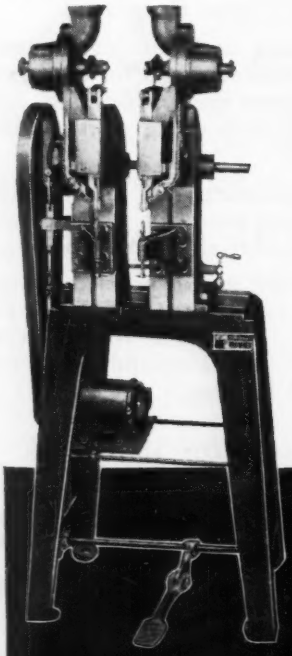

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Porcupine Co., The
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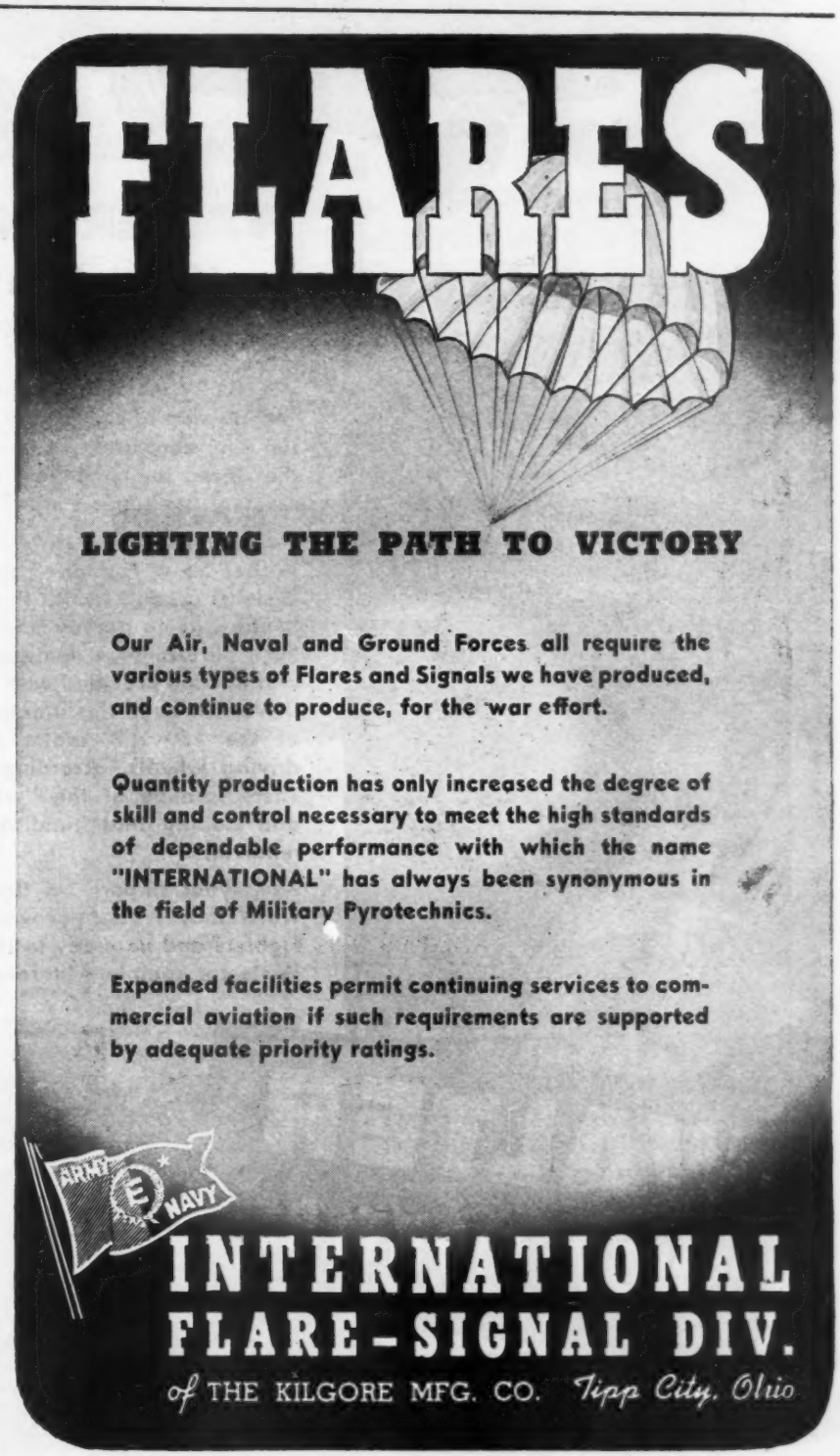
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ONLY Walter Snow Fighters have the speed and capacity to stay *ahead* of any blizzard. As a result, they keep runways constantly open—for emergency landings during the storm, for immediate resumption of normal traffic the moment the storm ends.

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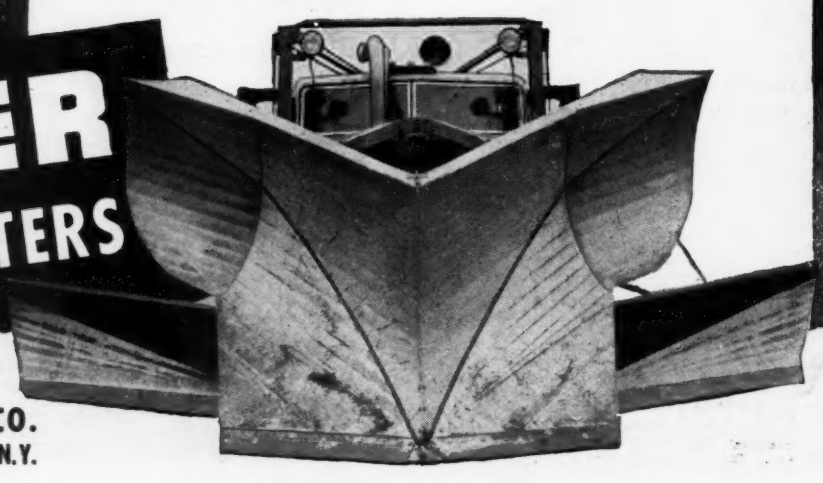

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uyahoga Spring Co.

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efiance Stamping Co.
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over Stamping & Mfg. Co.
unbar Brothers Co.
unbar Kapple, Inc.

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aton Mfg. Co. (Cleveland)
dwards Mfg. Co., The
lectric Auto Lite Co.
ngel Aircraft Specialties
rie Art Metal Co., Inc.
sick Mach. Co.
veready Hardware Mfg. Co., Inc.
xpert Die & Stamp Co., The

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irestone Steel Prods. Co.
orsberg Mfg. Co.
owler Aircraft Co.
ox Co.
ulton Co., The

eneral Aircraft Equipment, Inc.
ibson, Inc.
oat Co. ,Inc., The, Fred
oodyear Aircraft Corp.
rammes & Sons, Inc., L. F.
ray Mfg. Co., The
reist Mfg. Co.
riffith-Hope Co.
rossman Steel Stair Corp.
uarantee Specialty Mfg. Co.

agerstown Engraving Co.
aida Engineering Co.
all Lamp Co., C. M.
ardware Specialty Mfg. Co.
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auserman Co., Aircraft Div.
awks Co., R. A.
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eath Co.
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eyman Mfg. Co.
ighbridge International Co.
ighland Stamping & Mfg. Co.
indley Mfg. Co.
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ndustrial Washing Mach. Corp.

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arecki Mach. & Tool Co.
ensen Mach. Co., Inc.
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eith Mfg. Co.
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etal Products Engrg.
etal Specialty Co., The
idland Steel Products Co.
iller Co., The
iller Co., The, A. J.
iro-Flex Co.
onmouth Engr. Co.
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oss & Co., Henry
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eliable Spring & Wire Forms
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ipley Mfg. Co.
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ochester Mfg. Co.
ockwood Sprinkler Co.
ohr Aircraft Corp.
owe Industries
usgreen Mfg. Co.
ussakov Can Co.

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andsea Co., Harry
ervice Machine Co.
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kylark Mfg. Co., Inc.
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wix Mfg. Co., Inc.

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nited Screw & Bolt Corp.
. S. Spring & Bumper
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tility Fan Corp.

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eber Showcase & Fixture Co.
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estern Stamp & Stencil Co.
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illiamsport Die & Machine Co.
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inn's Sons, J. H.
ire Cloth Prods., Inc.
orcester Pressed Steel Co.
orcester Stamped Metal Co.
rought Washer Mfg. Co.
ork Currugating Co.
ork Safe & Lock Co.
oung Spring & Wire Corp., L. A.

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ell Corp.
ierold Metals Co.

86—STARTERS, GENERATORS, MAGNETOS, ETC.

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Apollo Magneto Corp.
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Bendix Aviation Corp., Phila.
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Delco-Remy Div.
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Eclipse Pioneer Div.
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Electric Sprayit Co., The
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McDowell Mfg. Co.
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Owen-Dyneto Div.
Pausin Engrg. Co.
Precision Aero. Corp.
Redmond Co., A. G.
St. Louis Engineering Co.
Toledo Standard Commutator Co.
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Western Activities
Western Mfg. Supply Co.
Westinghouse Elec. & Mfg. (Pittsburgh)

87—SUPERCHARGERS & EQUIPMENT

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General Alloys Co.
General Electric Co.
Industrial Washing Mach. Corp.
Liss Aircraft Prods. Co.
McCulloch Engineering Corp.
Mobile Refrigeration, Inc.
Modine Mfg. Co.
Monmouth Products Co.
Pesco Prod. Co.
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Western Gear Works

88—SWITCHES

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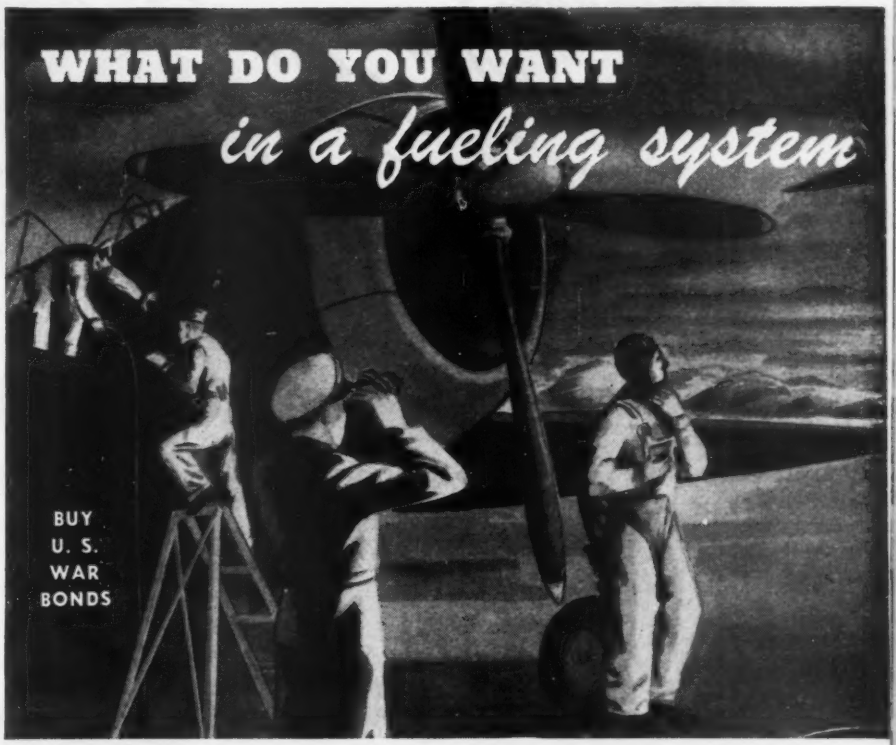

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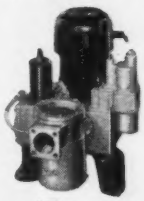

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Johnson Rubber Co., The
Kellogg Switchboard & Supply Co.
Kenyon Instrument Co.
Kohler Co.
Kulka Elec. Mfg. Co., Inc.
Lear Avia, Inc.
Lights, Inc.
Lowry Electrical Co., Inc.
Mallory & Co., Inc., P. R.
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Miller-Robinson Co.
Molded Insulation Co.
Mossman, Inc., Donald P.
Mu-Switch Corp.
National Acme Co., The
Pausin Engrg. Co.
Penn Electric Switch Co.
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Pollak Corp., Joseph
Poulsen & Nardon, Inc.
Quality Elec. Co., Ltd.
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Reynolds Spring Co.
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Sorensen & Co., Inc.
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Westinghouse Elect. & Mfg. Co.
Westinghouse Elec. & Mfg. Co., (Lima)
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Wilcolator Co., The
Worcester Stamped Metal Co.

89—TANKS & LEAKPROOFING

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Aircraft Metal Forming Co.
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Aluminum Gds. Mfg. Co.
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American Aviation Corp.
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Ariquipo, Inc.
Bellanca Aircraft Corp.
Benson Mfg. Co.
Budd Mfg. Co., E. G.
Butler Mfg. Co.
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Columbia Stamping & Mfg. Corp.
Columbian Rope Co.
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Engel Aircraft Specialties
Epison Aircraft Corp.
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Firestone Aircraft Co.
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Ingalls Iron Wks. Co.
International Engrg. Wks., Inc.
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Keystone Aircraft Products, Inc.
Lester Industries, Inc.
Littleford Bros., Inc.
Lyon Metal Products, Inc.
McQuay, Inc.
Mercury Aircraft, Inc.
Moss & Co., Henry
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National Radiator Co., The
Ohio Rubber Co.
Pacific Railway Equip. Co.
Paramount Rubber Co.
Pennsylvania Furnace & Iron Co.
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St. Louis Aircraft Corp.
Samson United Corp.
Southern California Air Parts
Sparks-Withington Co., The
Stevens, Inc., Fred. B.
Stoner-Mudge Co., Inc.
Summit Ind. Prod. Co
Taylorcraft Avia. Corp.
Timm Aircraft Corp.
United Oil Mfg. Co.
U. S. Rubber Co.
U. S. Stoneware Co., The
Utility Fan Corp.
Voit Rubber Co.
Weber Showcase & Fixture Co.
Welded Aircraft Parts Co.

90—TESTING EQUIPMENT & LABORATORIES

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Aero Research Wind Tunnel Co.
Aeromotive Prod. Corp.
Airadio, Inc.
Aircraft Accessories Corp. (K.C.)
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Allied Aviation Corp.
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American Time Products, Inc.
American Transformer Co.
Amthor Testing Instrument Co.
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Aviation Engineering, Inc.
B G Corp., The
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Baldwin Locomotive Wks.
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Barber-Colman Co.
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Bar Ray Products, Inc.
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Daven Co.
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Dillon & Co., Inc., W. C.
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Electric Products Co.
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Ferranti Electric, Inc.
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Hayes Mfg. Corp.
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Holley Carburetor Co.
Hydraulic Machinery, Inc.
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Industrial Sound Control
Instrument Laboratory, Inc., The
Interstate Brake Test.
J-B-T Instruments, Inc.
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Jamison Cold Storage Door Co.
Jones Motrola Sales Co.
Kenyon Instrument Co.
Knickerbocker Development Corp.
Kocour Co.
Kold-Hold Mfg. Co.
Kron Co., The
Lacey-Webber Co.
Larrimore Sales Co.
Lear Avia, Inc.
Lewis Engrg. Co., The
Liberty Motors & Engrg. Corp.
Lights, Inc.
Link-Belt Co.
Link Engrg. Co.
Los Angeles Heavy Hardware Co.
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Mallory & Co., Inc., P. R.
Martin-Decker Corp.
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Meriam Co., The
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Mico Instrument Co.
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Mine Safety Appliances Co.
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Radio Frequency Laboratories
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Scot & Co., Henry L.
Shallcross Mfg. Co.
Simmons Plating Wks.
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Sound Equip. Corp.
Sparkes Mfg. Co.
Standard Elec. Time Co., The
States Co., The
Steel City Testing Lab.
Stevens, Inc., Fred B.
Sticht Co., Inc., Herman H.
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Tenney Engrg., Inc.
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Torrington Mfg. Co., The
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Wellman Engineering Co., The
Westinghouse Elect. & Mfg. Co. (Balt. & Pitsburgh)
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York Corp.

91—TIRES & TUBES

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Armstrong Aircraft Co.
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Goodrich Co., The, B. F.
Goodyear Tire & Rubber Co., Inc.
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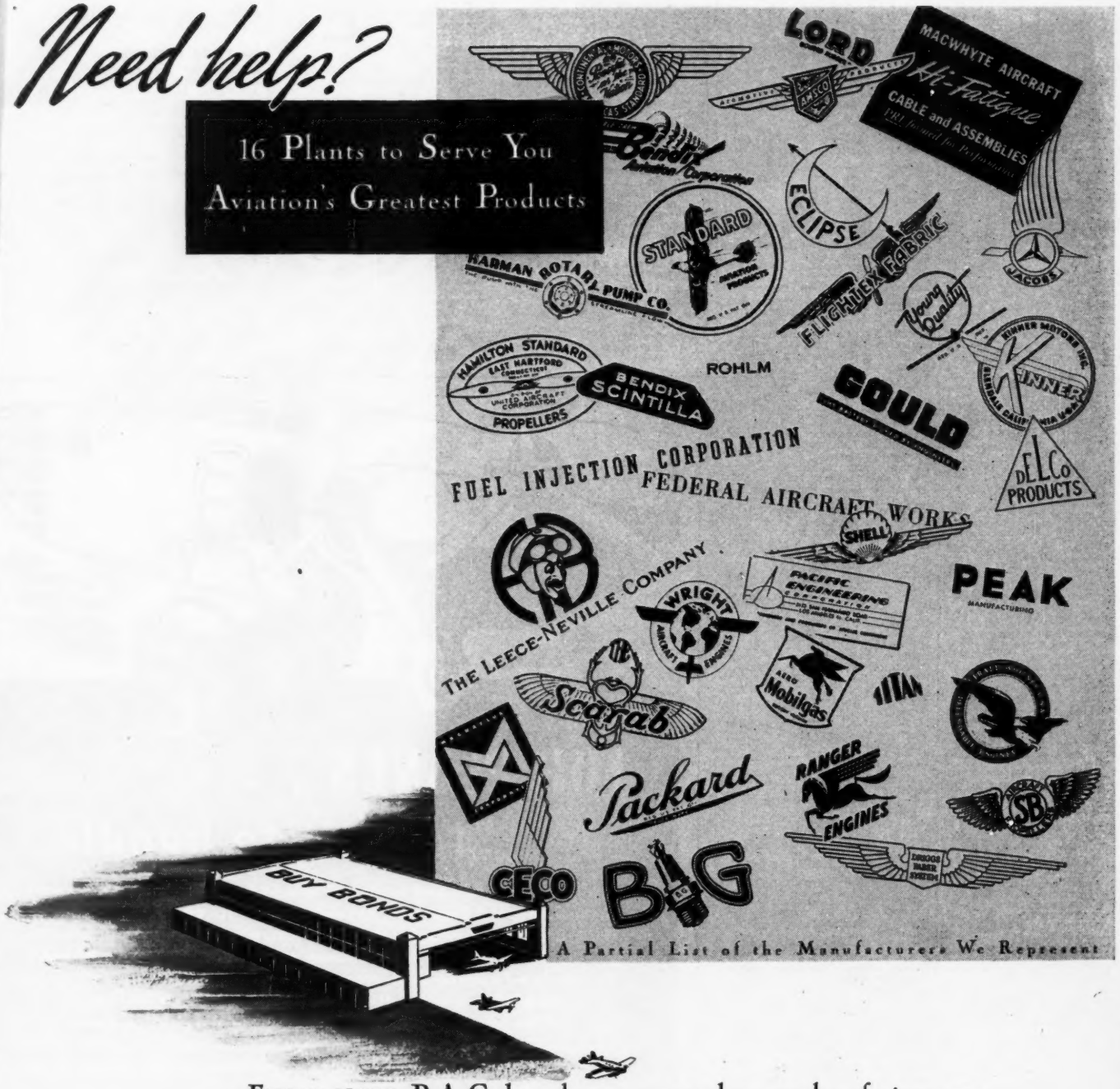

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Fairbanks Co., The
Fate-Root-Heath Co.
Ford Motor Co.
Fornaciari, Bert B.
Four Wheel Drive Auto Co., The
Garlinghouse Bros.
Gerstenslager Co., The
Gramm Truck & Trailer Corp.
"HH" Mfrs.
Hanson Cluth & Machy. Co., The
Hell Co., The
Howe Scale Co., The
Howell Industrial Truck Co., The
Industrial Supply Co., Inc.
International Engr., Inc.
Ironbound Box & Lumber Co.
Irvington Steel & Iron Wks.
Koenig, Edward L. & Co.
Lewis-Shepard Prods., Inc.
Lowry Electrical Co., Inc.
Lyon Raymond Corp.
Marmon-Herrington Co., Inc.
Mechanical Handling Systems
Nutting Truck Caster Co.
Ohio Galvanizing & Mfg. Co.
Porcupine Co., The
Rapids-Standard Co.
Revolvator Co.
Rocky Mountain Steel Products
Service Caster & Truck
Smith-Courtney Co.
Standard Pressed Steel Co.
Superior Grind. & Motor Parts
Towmotor Corp.
United Sanitary Chemicals Co.
Voight & Son Co., R.
Walter Motor Truck Co.
Wellington Machine Co., The
West Bend Equip. Corp.
Willamette-Hyster Co.

94—TUBING, RIGID—NON-FERROUS

Aircraft Metal Forming Co.
Aircraft Specialties Co.
Aluminum Co. of America
American Aviation Corp.
American Brass Co., The
Aurora Equipment Co.
Bakelite Corp.
Brasco Mfg. Co.
Brown Fence & Wire Co., The
Bundy Tubing Co.
Carbide & Carbon Chem. Corp.
Chase Brass & Copper Co.
Commercial Plastics Co.
Dockson Corp.
Downs Smith Brass & Copper
Drayer & Hanson, Inc.
Everhot Products Co.
Glove Steel Tubes Co.
Industrial Supply Co., Inc.
Industrial Synthetics Corp.
Linderme Tube Co., The
McInerney Plastics Co.
Metal Forming Corp.
Metal Goods Corp.
Mueller Brass Co.
Nat'l Copper & Smelting Co.
New York Brass & Copper Co.
Paneiste Div.
Penn Brass & Copper Co.
Plymold Corp.
Poulsen & Nardon, Inc.
Precision Tube Co.
Revere Copper & Brass, Inc.
Reynolds Metals Co.
Rusgreen Mfg. Co.
Spaulding Fibre Co.
Steel Forming Corp.
Stevens, Inc., Fred. B.
Strickland Aircraft Corp., The
Superior Tube Co.
Taylor Fibre Co.
Tull Metal & Supply Co., J. M.
U. S. Pipe & Mfg. Co.
United Wire & Supply Corp.
Wells & Co., Inc. A. H.
West Branch Novelty Co.
Whitehead Metal Prod. Co.
Wilmington Fibre Spec. Co.
Winchester Repeating Arms Co.,
Wolverine Tube Div.

95—TUBING, RIGID—STEEL

Aircraft Mechanics, Inc.
Aircraft Metal Forming Co.
Aircraft Specialties Co.
Aircraft Steel & Supply Co., The
American Aviation Corp.
Aurora Equipment Co.
Baker Steel & Tube Co.
Bissett Steel Co., The
Blum & Co., Inc., Julius
Brasco Mfg. Co.
Bright Steel Corp.
Brown Fence & Wire Co.
Carpenter Steel Co., The
Chicago Hardware Foundry Co.,
Columbia Steel Co.
Drayer & Hanson, Inc.
Everhot Products Co.
Frasse & Co., Inc., Peter A.
Globe Steel Tubes Co.
Hill-Chase & Co.
Industrial Supply Co., Ind.
Jackson Tube Co., Inc.
Metal Forming Corp.
Metal Goods Corp.
Michigan Seamless Tube Co.
Michigan Steel Tube Prods. Co.
Miller Co., The, A. J.
Miller Steel Co., Inc.
National Tube Co.
Ohio Seamless Tube Co.
Pacific Tube Co.
Pennsylvania Flexible Metallic
Pitsburgh Steel Co.
Pressed Steel Co.
Purdy, A. R.
Republic Steel Corp.
Revere Copper & Brass, Inc.
Rusgreen Mfg. Co.
Ryerson & Son, Inc.
Seattle Steel Co.
Service Steel Co.
Steel & Tubes Div.
Steel Forming Corp.
Strickland Aircraft Corp., The
Summerill Tubing Co.
Superior Tube Co.
Timken Roller Bearing Co., The
Trent Tubes Co.
Tube Methods, Inc.
Tubular Alloy Steel Corp.
Tubular Service Corp.
Tull Metal & Supply Co., J. M.
U. S. Pipe & Mfg. Co.
Welded Aircraft Parts Co.
Yoder Co., The

96—TUBING, OTHER

Aeroquip Corp.
Air Cruisers, Inc.
Aircraft Mechanics, Inc.
Aircraft Specialties Co.
American Aviation Corp.
American Brass Co., The
American Phenolic Corp.
Anchor Plastics Co.
Allegheny Ludlum Steel Corp.
Atlantic India Rubber Works
Atlas Asbestos Co.
Aurora Equipment Co.
Baker Steel & Tube Co.
Bishop & Co., Platinum Works, J.
Bowling Green Rubber Co.
Bozung, J. A.
Brasco Mfg. Co.
Breeze Products, Inc.
Brown Fence & Wire Co.
Buffalo Weaving & Belting Co.
Burndy Eng. Co., Inc.
Busser Supply Co.
California Nut & Bolt Co.
Canfield Co., The, H. O.
Chardon Rubber Co., The
Chase Brass & Copper Co.
Chicago Metal Hose Corp.
Clifford Mfg. Co.
Columbia Steel Co.
Commercial Plastics Co.
Conklin Brass & Copper Co.
Continental Rubber Wks.
Cook Elec. Co.
Dahlstrom Metallic Door Co.
Drayer & Hanson, Inc.
Dunne Rubber Co.
DuPont de Nemours & Co., Inc.
du Pont de Nemours & Co., Inc., E. I. (Plastics Dept.)
Elmhurst Rubber Co., Inc.
Erie Resistor Corp.
Fibre Conduit Co., The
Firestone Aircraft Co.
Firestone Rubber & Latex
Flex-O-Tube Co.
Formica Insulation Co., The
Franklin Fibre-Lamitex Corp.
Gates Rubber Co.
Gemloid Corp.
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Goodrich Co., The B. F.
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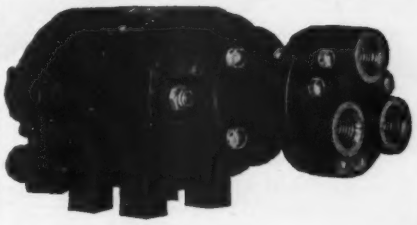

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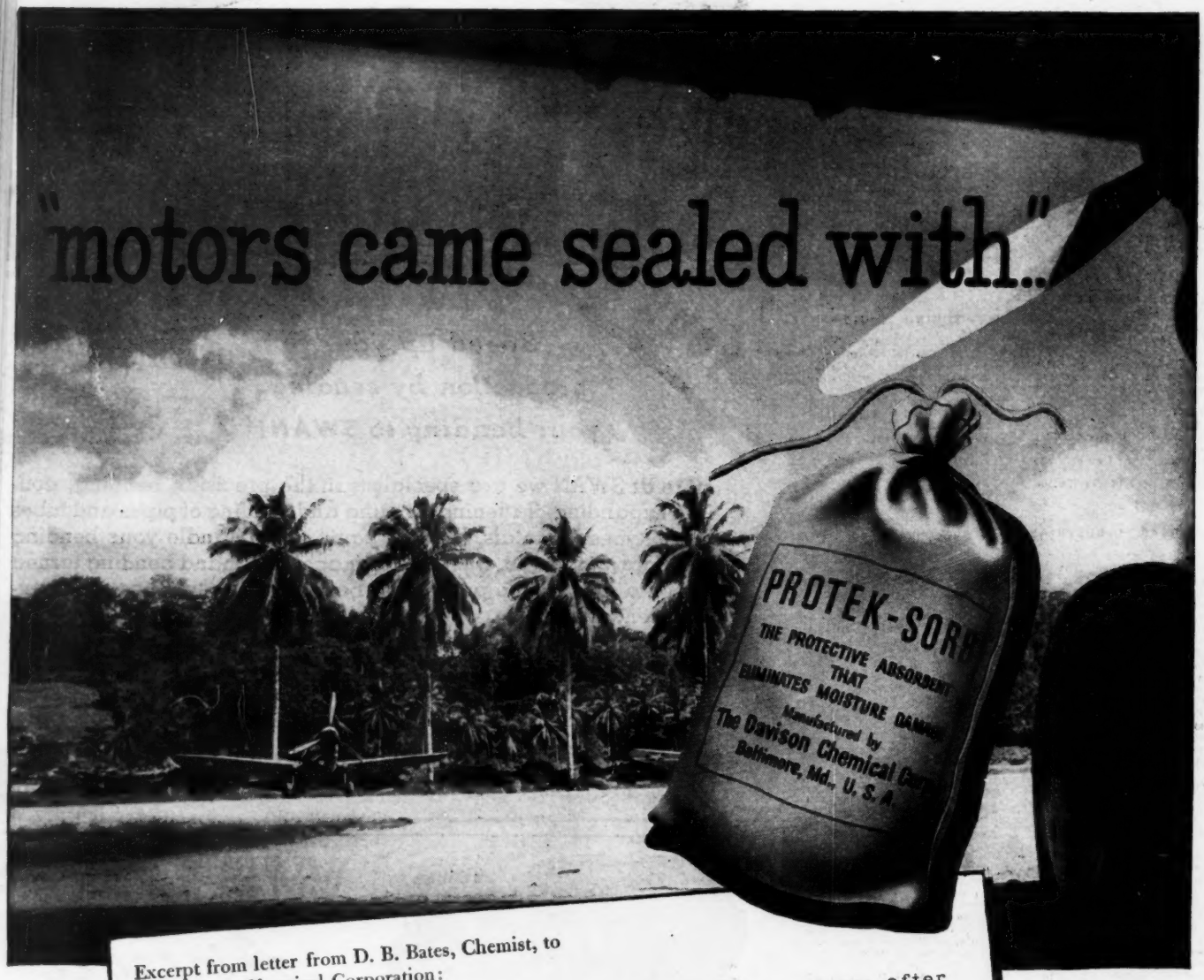

Excerpt from letter from D. B. Bates, Chemist, to the Davison Chemical Corporation:

"There was a young officer in the laboratory, home on leave after many months of service in the South Pacific. I asked if he had ever seen any Silica Gel. It was quite a common sight to him as he said all their motors came sealed with Davison Silica Gel as a desiccant."

The young officer said, "Davison Protek-Sorb Silica Gel was a common sight." We are proud of that and we are prouder of the uncommon service our product renders.

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2. It delivers fighting weapons to the service areas of the war fronts . . . clean and ready to use immediately.

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Johnson Rubber Co., The
Martin Rubber Co., Inc.
Miller Products Co., Inc.
Mitchell Rand Insulation Co.
Motor Products Corp.
National Electric Products Corp.
National Tube Co.
New England Tape Co., Inc.
New Jersey Wood Finishing Co.
Nixon Nitration Wks.
Ohio Rubber Co.
Panelyte Div.
Penn Brass & Copper Co.
Philpott Rubber Co., The
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Plastic Prod. Co.
Plastic & Rubber Products Co.
Plymold Corp.
Precision Tube Co.
Prudential Mach. Corp.
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Republic Rubber Div.
Republic Steel Corp.
Resistoflex Corp.
Rodic Rubber Corp.
Rusgreen Mfg. Co.
Saylor Electric Products Corp.
Shakespeare Products Co.
Snyder & Son, M. L.
Sponge Rubber Products Co.
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Strickland Aircraft Corp., The
Summerill Tubing Co.
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Tensolite Corp., The
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U. S. Rubber Co.
U. S. Steel Supply Co.
U. S. Stoneware Co., The
United Wire & Supply Corp.
Wagner Mfg. Co., E. R.
Wallace Supplies Mfg. Co.
Welded Aircraft Parts Co.
Werner Co., Inc., R. D.
West American Rubber Co.
Western Felt Works
Wiremold Co., The

97—TURRETS & PARTS

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Aircraft Industries Corp.
Aircraft Products, Inc.
Alexander Tool & Mfg. Co.
Aluminum Gds. Mfg. Co.
Anheuser Busch, Inc.
B. J. Machine Shop
Baldwin-Duckworth Div.
Bendix Products Div.
Borg Warner Corp.
Briggs Mfg. Co.
Cardinal Corporation, The
Char Gale Mfg. Co.
Clarke Aero-Hydraulics, Inc.
Cunningham Hall Aircraft Corp.
Detroit Macoid Corp.
Emerson Electric Mfg. Co., The
Emerson Engrg. Co.
Eureka Vacuum Cleaner Co.
Expert Die & Stamp Co., The
Firestone Aircraft Co.
Flour City Ornamental Iron Co.,
General Electric Co.
Guardian Electric Co.
Livingston Machine Shop
Logan Engrg. Co.
Marine Air Research Corp.
Maxson Corp., The, W. L.
Memphis War Industries, Inc.
Moss & Co., Henry
Motor Products Corp.
Murray Corp. of America
Plastic Manufacturers, Inc.
Plastics Moulding Corp.
Reliable Spring & Wire Forms
Reynolds Molded Plastics, Div.
Samson United Corp.
Steel Products Engrg. Co., The
Tietzmann Engrg. Co.
Torrance Precision Mfg. Co.
Universal Engrg. Corp.
Vendo Co., The
Vickers, Inc.
Westinghouse Elect. & Mfg. Co.
Winborne Plastics Moulding Corp.
York Shipley, Inc.

98—VALVES & PARTS

A & F Aluminum Prods. Co.
Adel Precision Products Corp.
Aero Supply Mfg. Co., Inc.
Aeromotive Prods. Corp.
Aeronautical Mfg. Corp.
Aeronautical Products, Inc.
Aeronautical Trading Co.
Air Cruisers, Inc.
Aircraft Accessories Corp. (Cal.)
Aircraft Industries Corp.
Aircraft Welders, Inc.
Airex Mfg. Co.
Alco Valve Co.
Alexander Tool & Mfg. Co.
American Chain & Cable Co.
American Liquid Gas Corp.
American Non Gran Bronze Corp.
American Screw Products
Barber-Colman Co.
Barco Mach. Prods. Co.
Barnes Corp., John S.
Ben. Mfg. Co., The
Bendix Aviation, Ltd.
Borg Warner Corp.
Buckeye Iron & Brass Works
Burdett Mfg. Co.
Busser Supply Co.
Caley & Co., W. S.
Cash Co., A. W.
Century Aircraft Co.
Chapin Co., Chas. E.
Chapman Valve Mfg. Co.
Chase Brass & Copper Co.
Chicago Hardware Foundry Co.
Clarke Aero-Hydraulics, Ind.
Collins Engineering Co.
Comet Mfg. Co.
Daworth Eng. & Mfg. Co.
Detroit Gear Aircraft Parts Div.
Detroit Lubricator Co.
Dix Machine Works
Dolan Aircraft Mfg. Co.
Dole Valve Co., The
Domestic Mfg. Co.
Dunbar Kapple, Inc.
Dyco Engrg. & Sales
Eclipse-Pioneer Div.
Electric Sprayit Co., The
Elkhart Brass Mfg. Co.
Erie Concrete & Steel Supply Co.
Fairbanks Co., The
Fleetwings Div. Kaiser Cargo
Fuel Development Corp.
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Gardner Co., J. R.
General Controls
Gilfillan Bros., Inc.
Greer Hydraulics
Goodyear Aircraft Corp.
Hagedorn Engineering
Hallett Mfg. Co.
Hawks Co., R. A.
Haynes Stellite Co.
Henry Valve Co.
Hoof Prods. Co.
Houde Engrg. Div.
Hydropack
Industrial Tool & Die Wks., Inc.
Kenyon Instrument Co.
Koehler Aircraft Prods. Co.
Kohler Co.
LaSalle Furniture Co.
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Livingston Machine Shop
Lorenzen Industries
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Mueller Brass Co.
Ogden Filter Co.
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Panelyte Div.
Parker Appliance Co., The
Peerless Mach. Co.
Perlick Brass Co., R.
Persons Corp., L. M.
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Peterson, F. Somers Co.
Plastic Prod. Co.
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Rodman & Co.
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Schrader's Son, A.
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Shields, Harper & Co.
Sibley Mach. & Fdry. Corp.
Speedometer Service & Accessories
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Stevens, Inc., Fred. B.
Stow Mfg. Co., Inc.
Stritt & Priebe, Inc.
Swift Lubricator Co., Inc.
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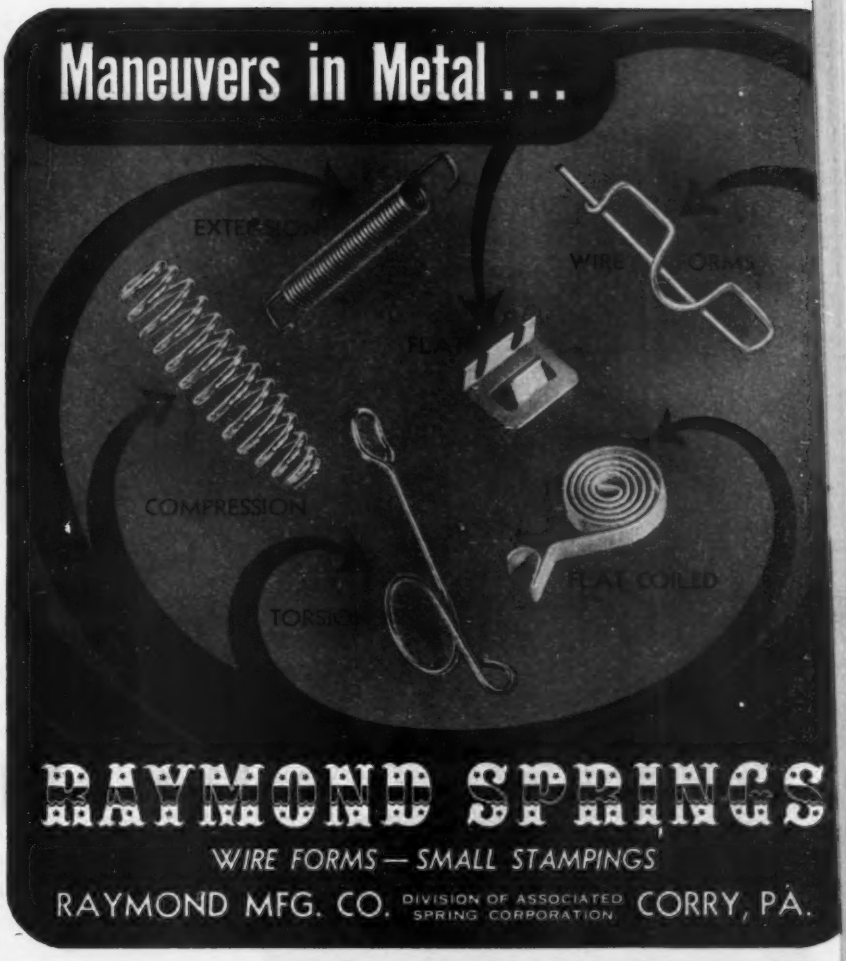
Thompson Products, Inc.
Timken Detroit Axle Co., The
Titan Valve & Mfg. Co., The
Torrance Precision Mfg. Co.
U. S. Pipe & Mfg. Co.
Vic Cleaning Mach. Co.
Vickers, Inc.
Walworth International Co.
Watson-Stillman Co.
Weatherhead Co., The
Westinghouse Air Brake Co.
Wharry & Co., Inc., G. A.
Whittaker Co., Ltd., Wm. R.
Worcester Stamped Metal Co.

98a—VENEERS see 70

99—VIBRATION DAMPENERS & PADS

American Felt Co.
Armstrong Cork Co.
Boothfelt Co., The
Buffalo Weaving & Belting Co.
Burlington Mills, Inc.
Bushings, Inc.
Celotex Corp., The
Comstock & Co.
Connecticut Hard Rubber Co.
Continental Rubber Wks.
Elmhurst Rubber Co., Inc.
Fabreeka Products Co.
Felters Co., Inc.
Gasket Shop, The
General Tire & Rubber Co., The
Goodrich Co., The, B. F.
Goodyear Tire & Rubber Co.
Harris Prods. Co.
Holfast Rubber Co., The
Houde Engrg. Div.
Ideal Roller & Mfg. Co.
L. A. Rubber & Asbestos Works
Lord Mfg. Co.
Manhattan Rubber Mfg. Div.
Martin Rubber Co., Inc.
National Automotive Fibres, Inc.
Packless Metal Prods. Corp.
Prince Rubber Co., Inc.



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Tyer Rubber Co.
Tyson Bearing Co.
U. S. Rubber Co.
Van Cleef Bros.
West American Rubber Co.

100—WELDING EQUIPMENT

Acme Electric Welder Co.
Air Reduction Sls. Co.
Aircraft Mechanics, Inc.
Allis Chalmers
American Aviation Corp.
American Brake Shoe
American Brass Co., The
American Chain & Cable Co.
American Solder & Flux Co.
Apex Steel Corp., Ltd.
Atlas Welding Accessories Co.
Bausch & Lomb Optical Co.
Bonney Forge & Tool Wks.
Bostitch, Inc.
Brand Tool & Supply Co.
Busser Supply Co.
Carter-Lockard Co.
Chase Brass & Copper Co.
Chanslor & Lyon Co.
Chicago Hardware Foundry Co.
Cleveland Aircraft Products Co.
Commerce Pattern Fdry & Mach. Co.
Conse Laboratories, Inc.
Croton Chemical Corp.
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Daniels, Inc., C. R.
Dickens, Inc.
Dockson Corp.
Electric Arc, Inc.
Electric Products Co.
Engolyte Mfg. Co.
Eutectic Welding Alloys Co.
Federal Aircraft Wks.
Federal Mach. & Welder Co.
Frostrode Prods.
Gas Gun Co., Inc.
Gay Engrg. Corp. of Cal.
General Electric Co.
Glenn-Roberts Co.
Grob Bros.
Harnischfeger Corp.
Harris Calorific Co.
Hayes Mfg. Corp.
Haynes Stellite Co.
Hobart Bros.
Hockaday Aircraft Corp.
Hockaday & Phillips, Inc.
Imperial Brass Mfg. Co., The
Industrial Gloves Co.
Industrial Supply Co., Inc.
Judson-Pacific Co.
Kimmont Mfg. Co.
L. A. Automotive Wks.
Lepel High Frequency Labs.
Lights, Inc.
Lincoln Elec. Co., The
Linde Air Prods. Co.
Los Angeles Heavy Hardware Co.
Lowry Electrical Co., Inc.
Lyon Metal Products, Inc.
Mallory & Co., Inc., P. R.
Metal & Thermit Corp.
Metal Prods. Corp.
Metal Products Engrg., Inc.
Midland Paint & Varnish Co.
Milburn Co., The, Alexander
Modern Engrg. Co., Inc.
Morris, Wheeler & Co.
Mullenbach Electrical Mfg. Co.
National Cylinder Gas Co.
National Elec. Welding Mach.
Neal Co., Inc., R. C.
Park Stewart
Pier Equip. Mfg. Co.
Progressive Welder Co.
Rising, H. G.
Reuther Equip. & Paint Co.
Revere Elec. Mfg. Co.
St. Louis Engineering Co.
Sandsea Co., Harry
Sciaky Bros.
Seattle Steel Co.
Service Machine Co.
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Smith-Courtney Co.
Smith Welding Equip. Corp.
Southern Cal. Plating Co.
Southern Oxygen Co., Inc.
Sterling Electric Co.
Strickland Aircraft Corp., The
Taylor-Winfield Corp.
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Tool Service Co.
Tull Metal & Supply Co., J. M.
Turtle & Hughes, Inc.
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U. S. Spring & Bumper Co.
U. S. Steel Supply Co.
United Wire & Supply Corp.
Utility Fan Corp.
Victor Equip. Co.
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Ward Machinery Co.
Welding Machines Mfg. Co.
Welding Service Sales, Inc.
Weldit Actyline Co.
Weltronic Corp.
Western Arc Welding, Inc.
Westinghouse Elec. & Mfg. Co. (Sharon, Pa.)
Wetzler Clamp Co., The
Whitehead Metal Prod. Co.
Wilson Welder & Metals Co.
York-Shipley, Inc.

101—WINDSHIELD WIPERS

Air Cruisers, Inc.
Alco Valve Co.
Bowling Green Rubber Co.
E. A. Laboratories, Inc.
Firestone Aircraft Co.
Fulton Co., The
Hockaday & Phillips, Inc.
Marquette Metal Prods. Co., The
National Pneumatic Co.
Quaker Rubber Corp.
Reuther Equip. & Paint Co.
Stewart Warner Corp.
Trico Products Corp.

102—WIRE & CABLE—ELECTRICAL

Accurate Insulated Wire Corp.
Air Associates, Inc.
Air Parts, Inc.
Airadio, Inc.
Aircraft Instrument Service, Inc.
Alloy Metal Wire Co., Inc.
Aluminum Co. of America
American Brass Co., The
American Phenolic Corp.
American Steel & Wire Co.
Anaconda Wire & Cable Co.
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Bethlehem Equip. Corp., Ltd.
Borg Warner Corp.
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Chautauqua Swaging Co.
Collyer Insulated Wire Co.
Columbia Steel Co.
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Copperweld Steel Co. (Glassport)
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Crescent Insulated Wire & Cable
Dockson Corp.
Driver Co., Wilbur. B.
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Electric Auto Lite Co.
Electric Auto Lite Wire Division
Garfield Electrical Supply Co.
General Cable Corp.
General Electric Co.
General Elec. Co. (Conn.)
Geophysical Instr. Co.
Gilfillan Bros., Inc.
Hazard Insulated Wire Wks. Div.
Hockaday & Phillips, Inc.
Kellogg Switchboard & Supply
Kennecott Wire & Cable Co.
Kerite Insulated Wire & Cable
Kulka Elec. Mfg. Co., Inc.
Lentz Elec. Mfg. Co.
Lowry Electrical Co., Inc.
Malin & Co.
National Electric Products Corp.
National Pneumatic Co.
Nesor Alloy Products Co.
New York Brass & Copper Co.
Okonite Co., The
Packard Elec. Div. Gen. Motors
Precision Tube Co.
Radio Wire Television, Inc.
Reuther Equip. & Paint Co.
Reynolds Metals Co.
Rising, H. G.
Rockbestos Prods. Corp.
Roebling's Sons Co., John A.
St. Louis Engineering Co.
Saylor Electric Products Corp.
Scintilla Magneto Div.
Searle Aero Industries, Inc.
Stamford Metal Specialty Co.
Sterling Cable Div. Elec. Autolite
Tensolite Corp., The
Thompson Electric Co.
Thwing-Albert Instrument Co.
Turtle & Hughes, Inc.
U. S. Rubber Co.
Western Insulated Wire, Inc.
Willard Storage Battery Co.

103—WIRE & CABLE—MECHANICAL & FLEXIBLE SHAFTS

Aircraft Instrument Service, Inc.
Alloy Metal Wire Co., Inc.
American Brass Co., The
American Cable Div.
American Chain & Cable Co.
American Chain Div.
American Phenolic Corp.
American Steel & Wire Co.
Anaconda Wire & Cable Div.
Bethlehem Equip. Corp., Ltd.
Bridgeport Chain & Mfg. Co.
Broderick & Bascom Rope Co.
Buckeye Tool & Supply Co.
Chain Belt Co.
Chase Brass & Copper Co.
Columbia Steel Co.
Continental Steel Corp.
Copperweld Steel Co. (Glassport)
Cuyahoga Spring Co.
Diamond Chain & Mfg. Co.
Electric Steel Foundry Co.
Fisher Spring Co., Chas.
Gilfillan Bros., Inc.
Hackensack Cable Corp.
Hazard Wire Rope Div.
Industrial Supply Co., Inc.
International Banding Machine
Jarvis Co., The Chas. L.
Johnson Steel & Wire Co., Inc.
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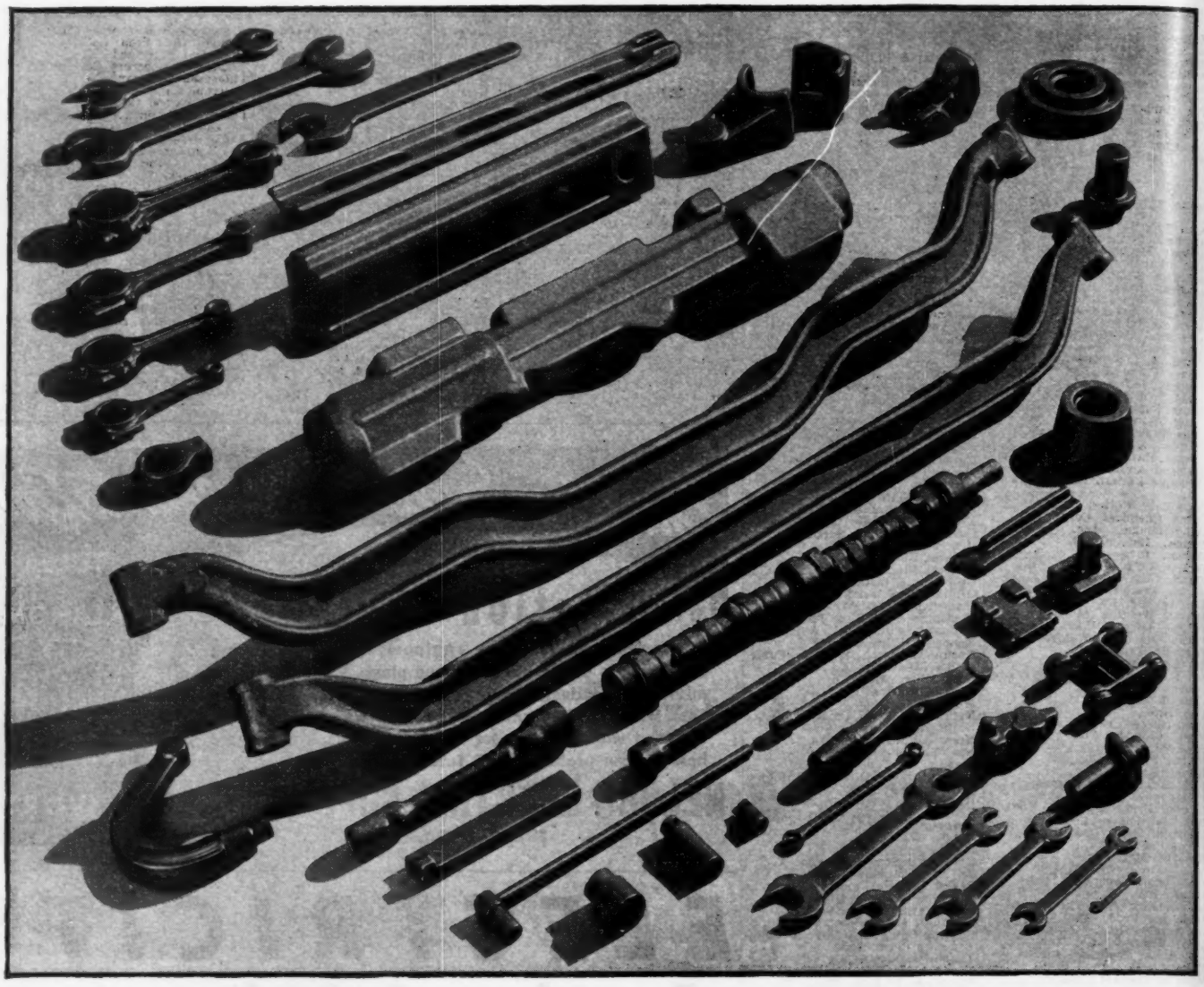

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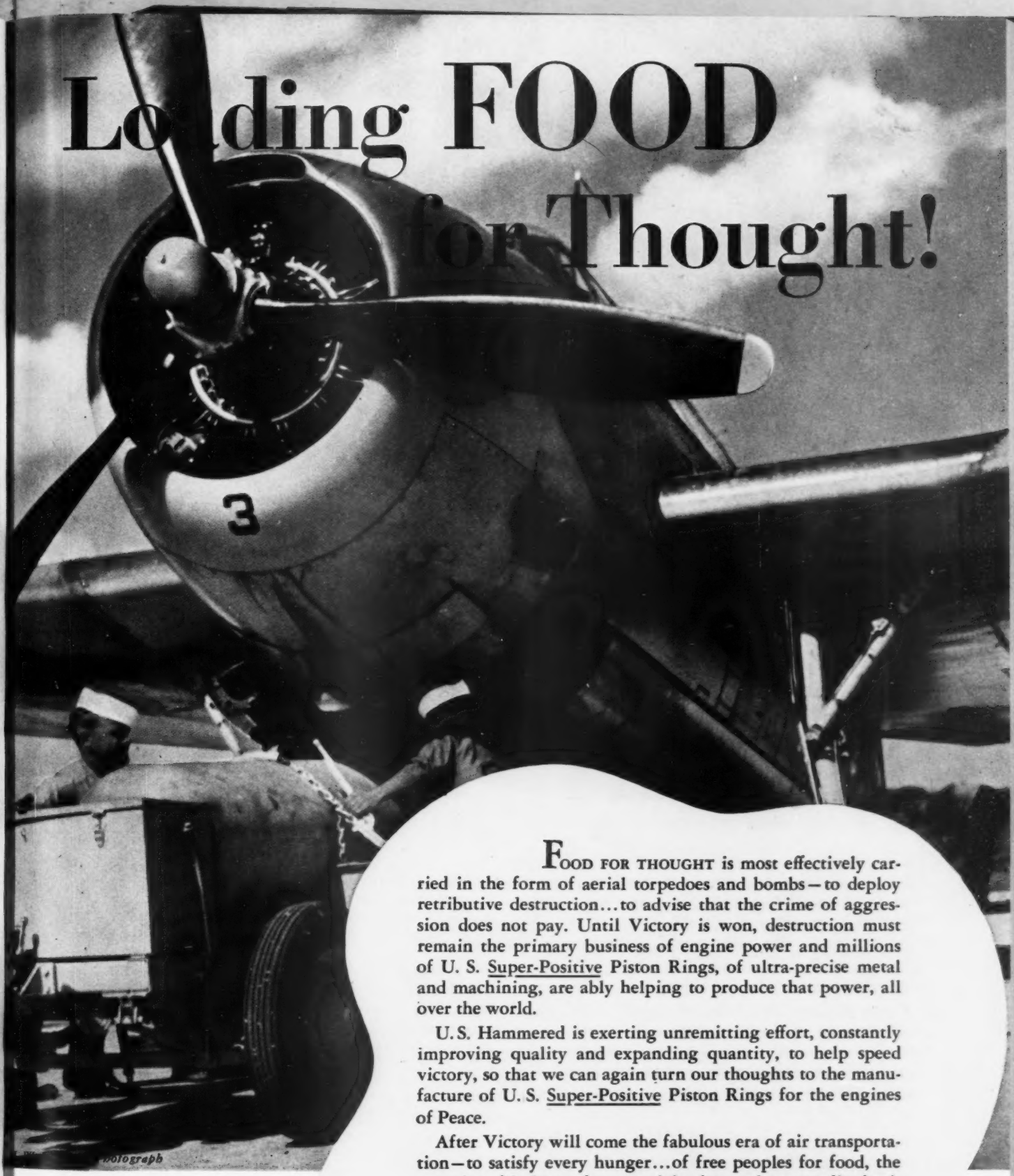

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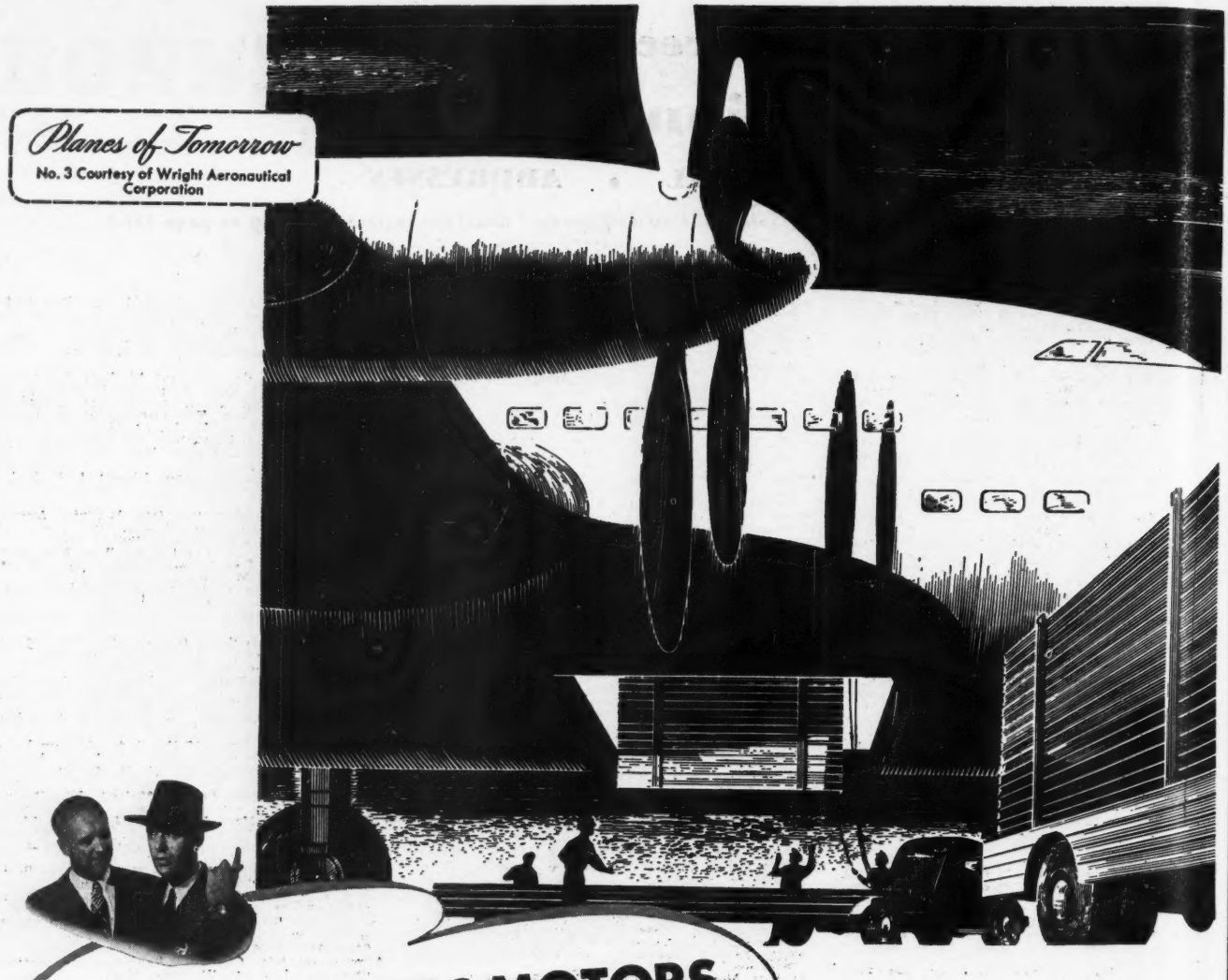

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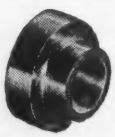

Aircraft Instrument Panel Control Wire Bushing. Hole .187" diameter — held to .0002", stock removal .001", sixty per hour.

Header Die. Life of header dies increased 3 to 9 times over lapping. Knockout pin breakage practically eliminated.

Aircraft Hydraulic Brake Cylinder. Honing 3 times faster than lapping—and gave a straighter hole.

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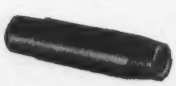
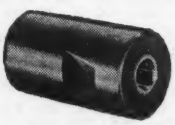


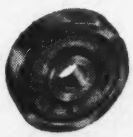
Cast Iron Valve Stem Guide. ½ to one thousandth removed —220 pieces per hour. Better finish and straighter hole.

Stainless Steel Load Compensator Valve Seat. Hole is honed to .0002" limit.



Shell Loading Die.

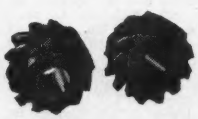
Idle Valve Guide. Honing after grinding holds a .0002" limit necessary for accurate idling.



Aircraft Valve Tappet Roller. Honed after grinding to give 100% bearing surface.

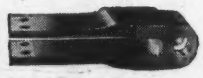
Hydraulic Control Bushing. Honing gives straight round hole after rough reaming.

Aircraft Carbureter Operating Valve Sleeve. Sunnen honing eliminates distortion from assembling operation.



Automobile Distributor Shaft Gears. Taper removed at a rate of 80-90 per hour.

Compressor Yoke. Alignment maintained and better finish produced.



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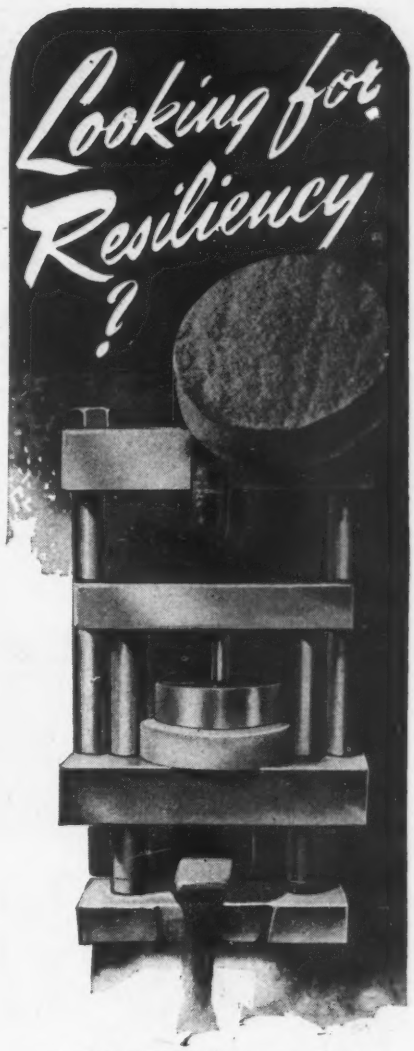

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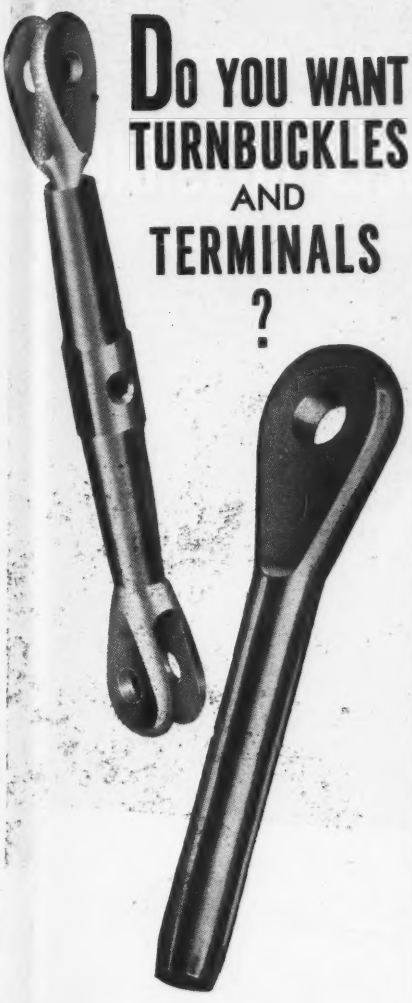

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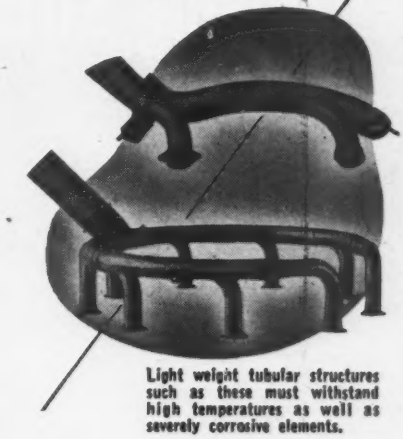

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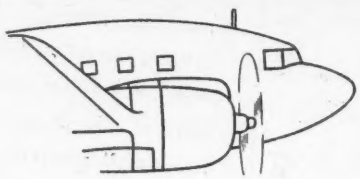

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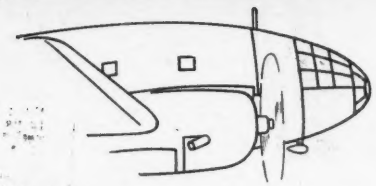

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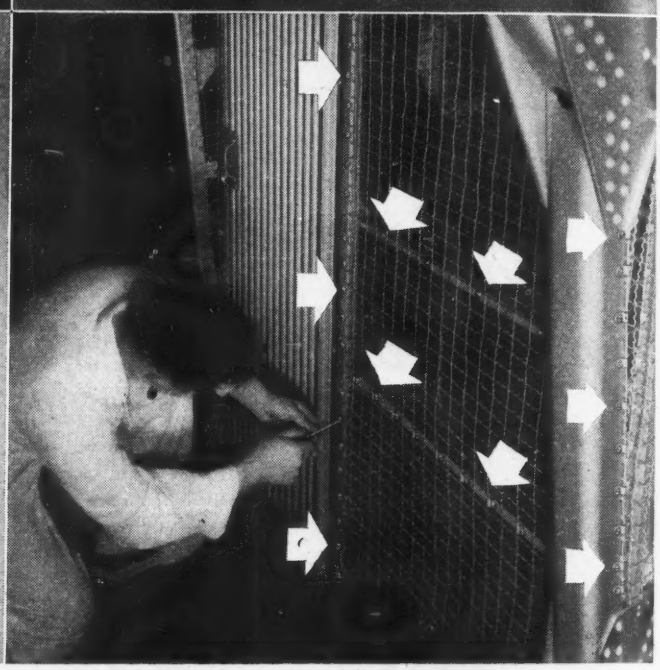

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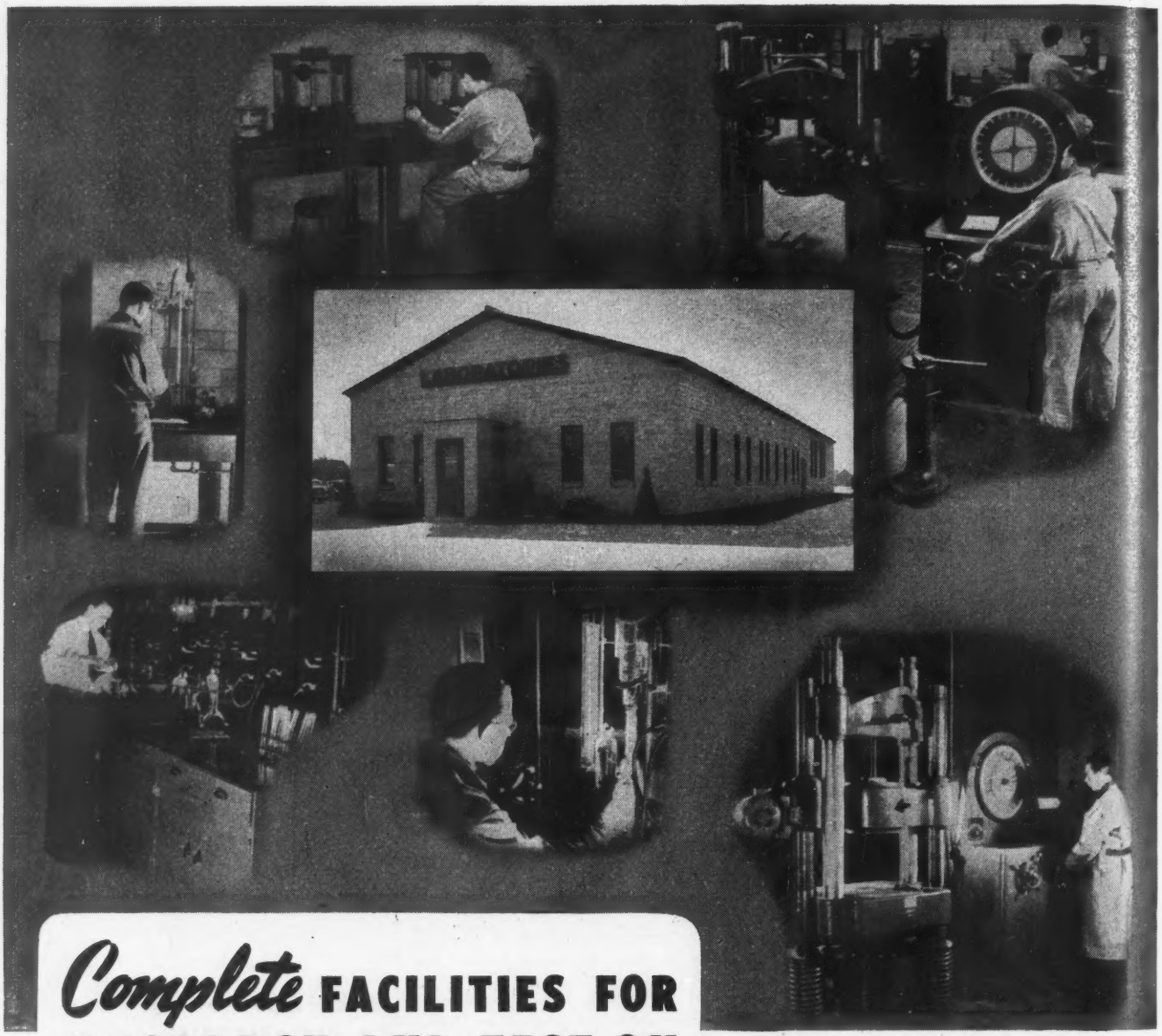

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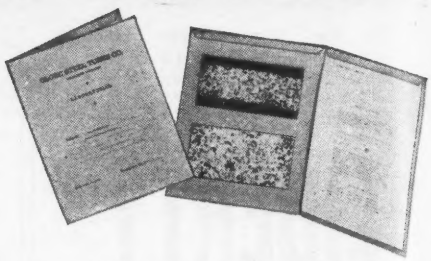

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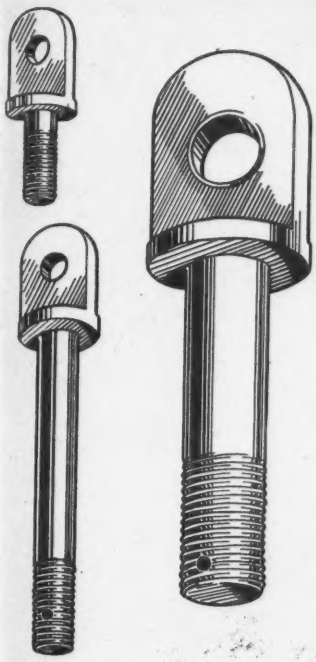

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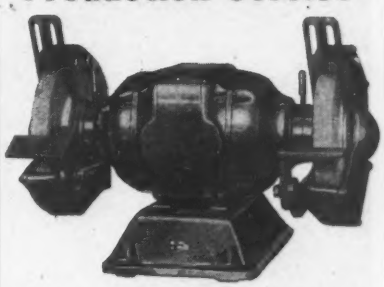

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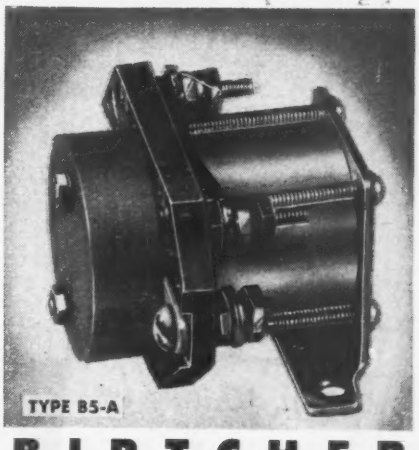

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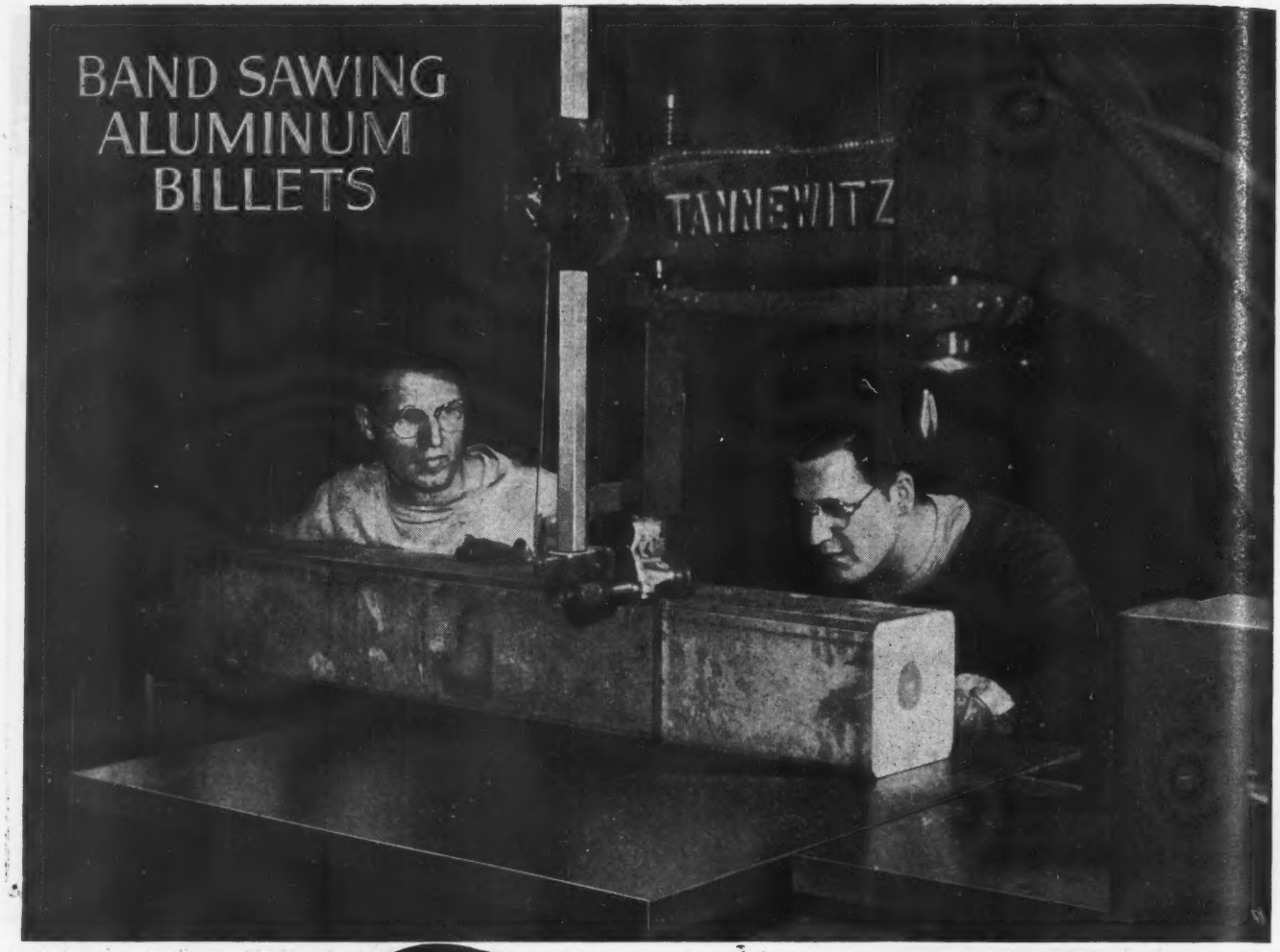

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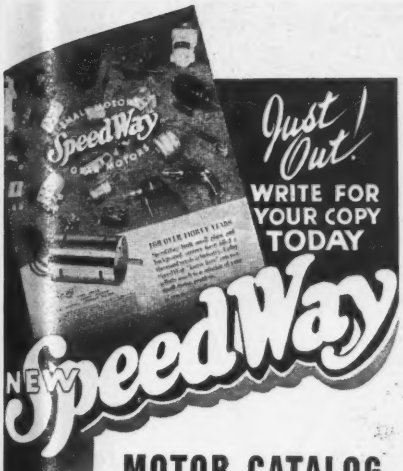

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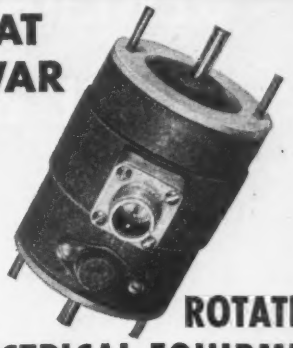

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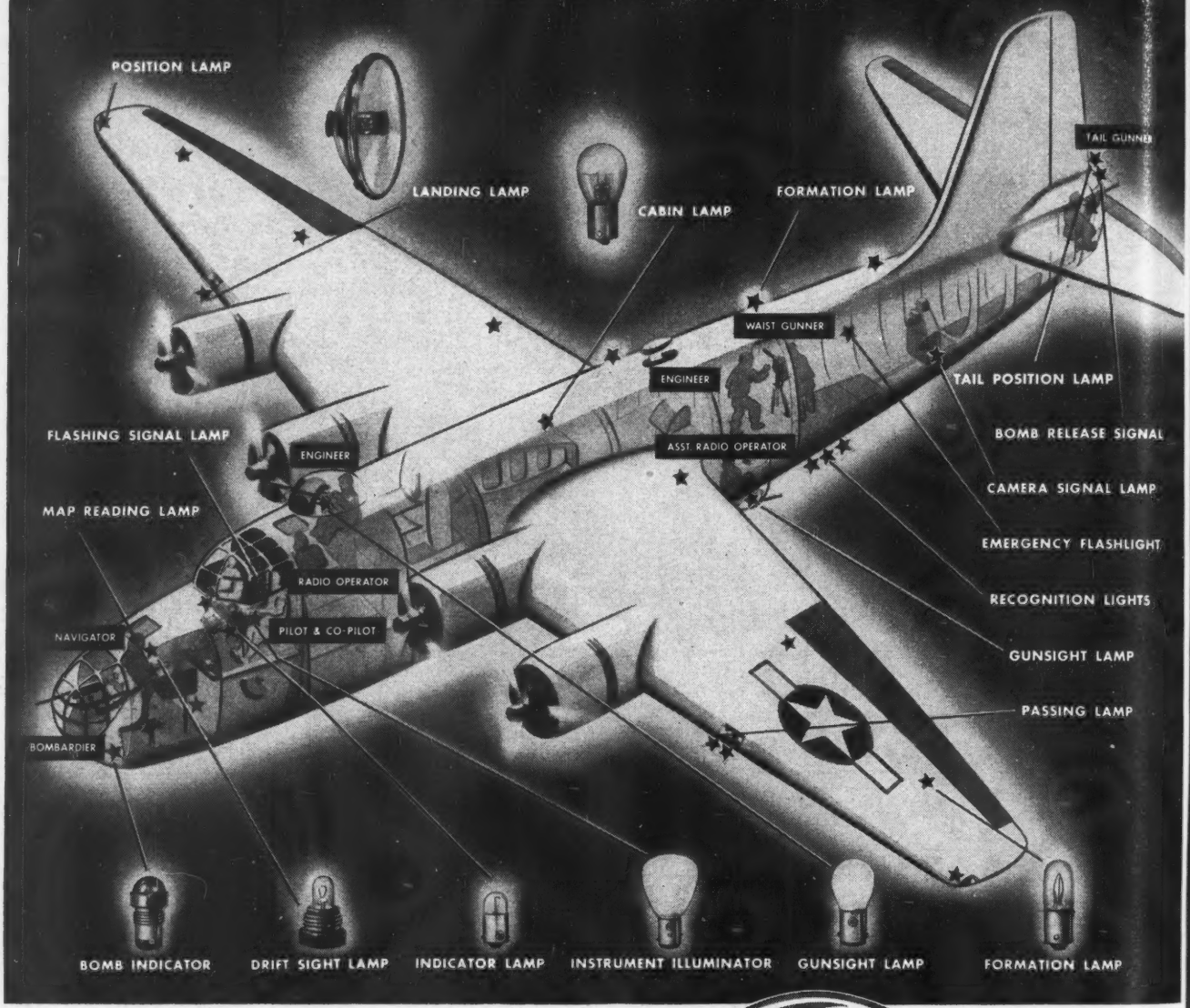

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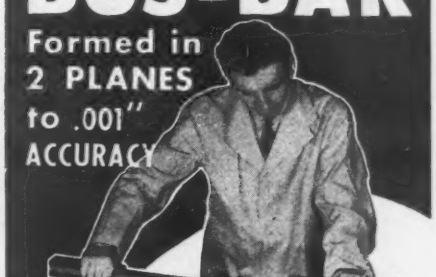

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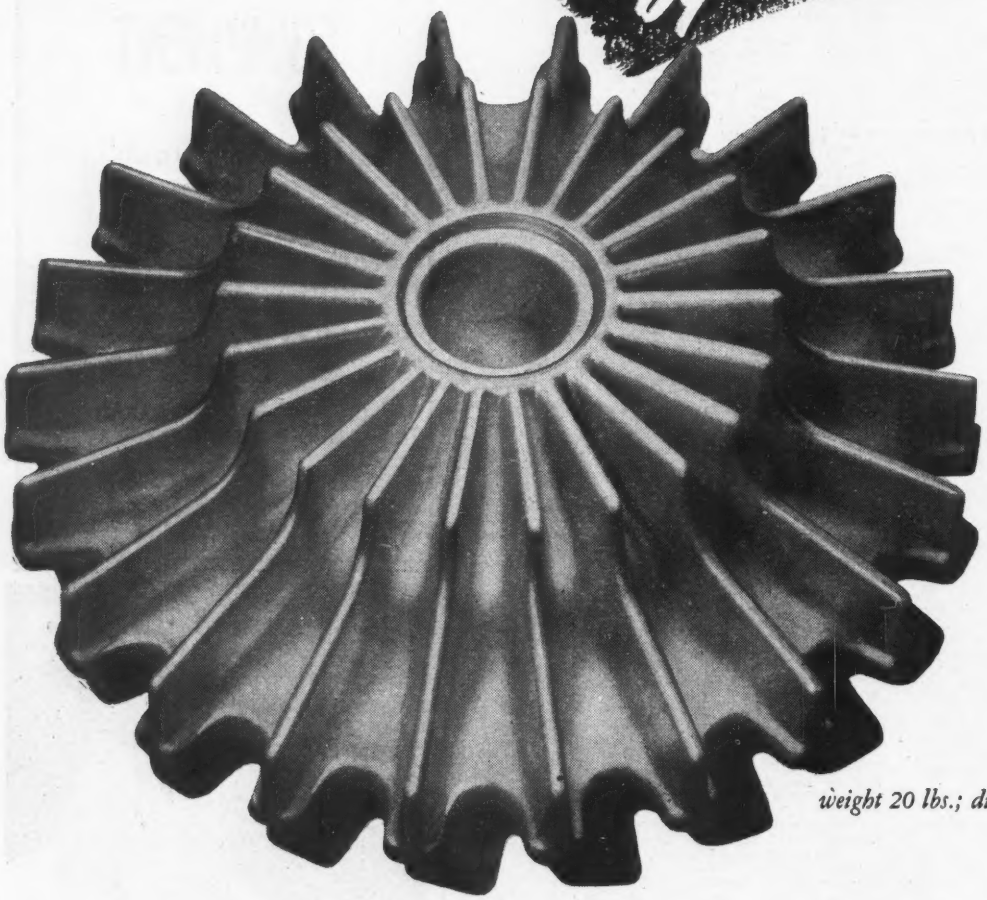

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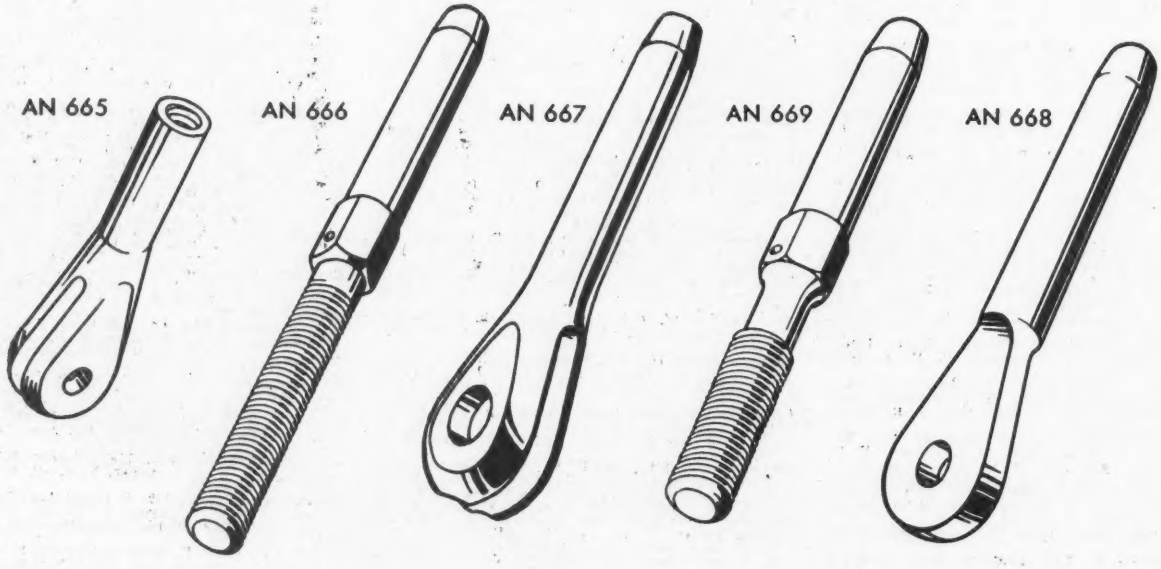

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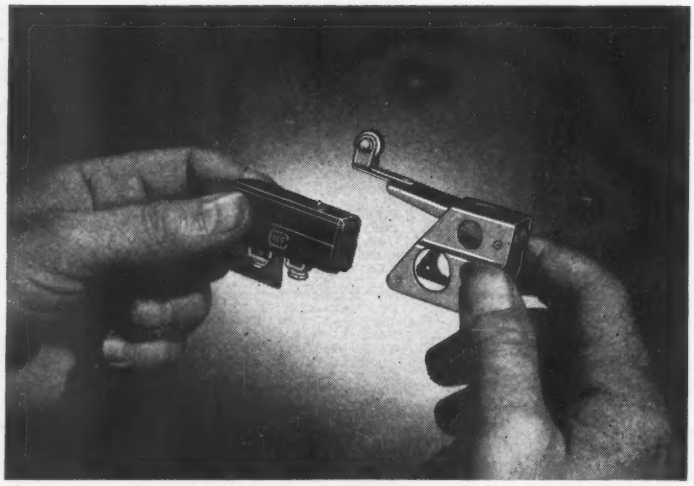

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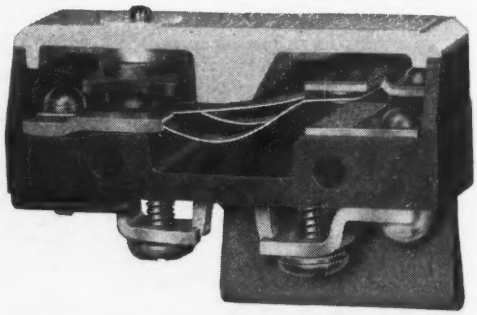

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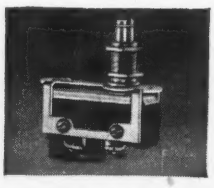
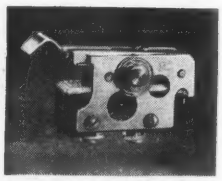
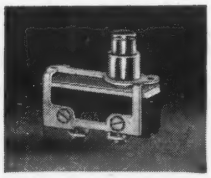


An example of the Type "M" series of panel mount brackets. These come in three lengths of threaded stems for easy positioning and providing overtravel of ¼" or ⅜". Operation takes place in first 1/32" of plunger travel.



The Type "T" bracket shown here has been widely used as a throttle warning switch, singly or in gangs. It is operated by cams on the throttle quadrant, or dogs on cables. It is a sturdy mount and actuator for use as a limit switch.



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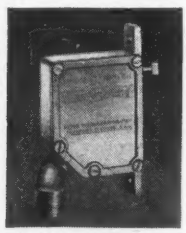

Example of the Type "H" series of aluminum housings. Can be sealed against dirt, splash, or oil. "A-N" outlet fittings may be straight or adjustable to 45 degrees.

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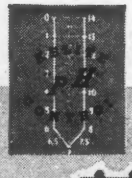

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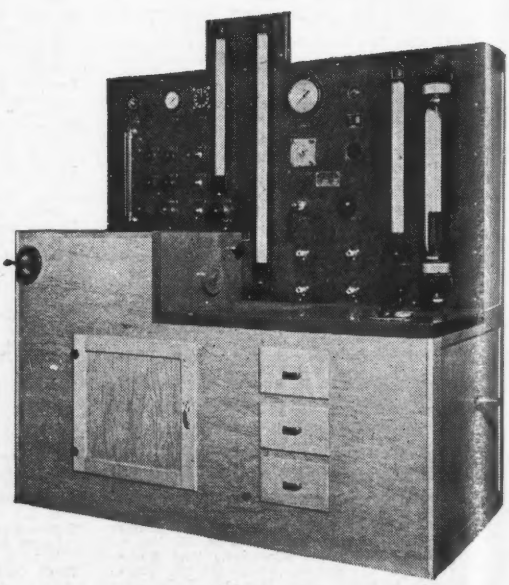

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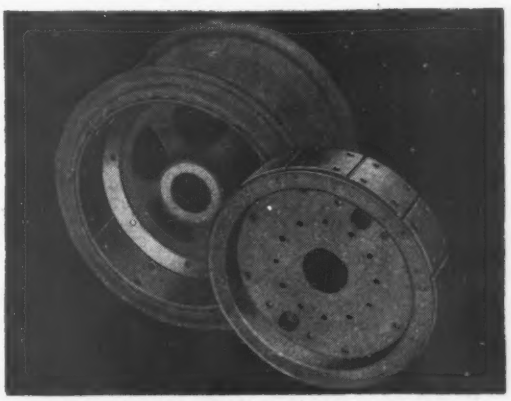

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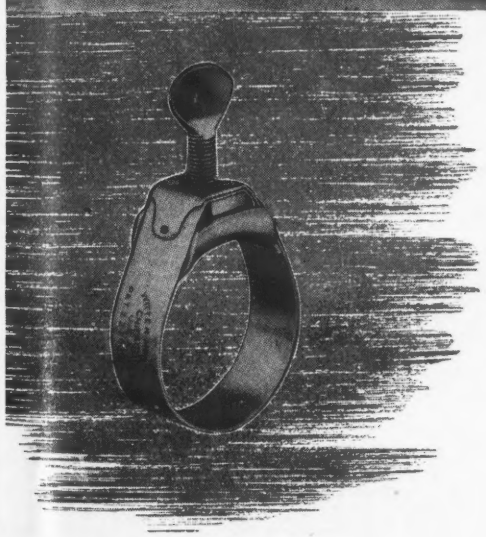

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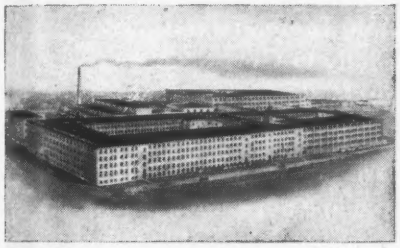

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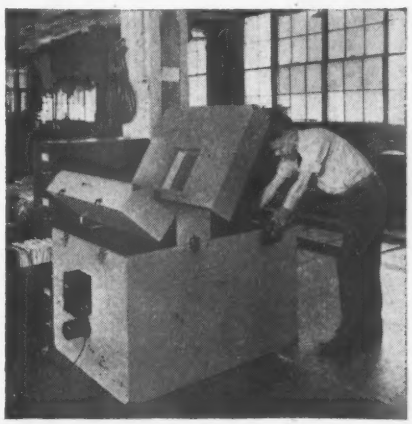

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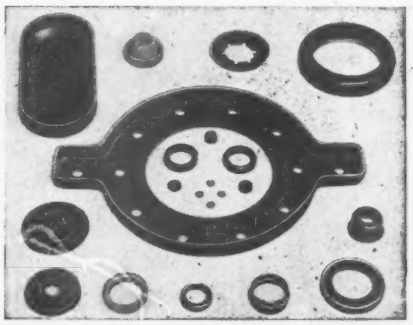

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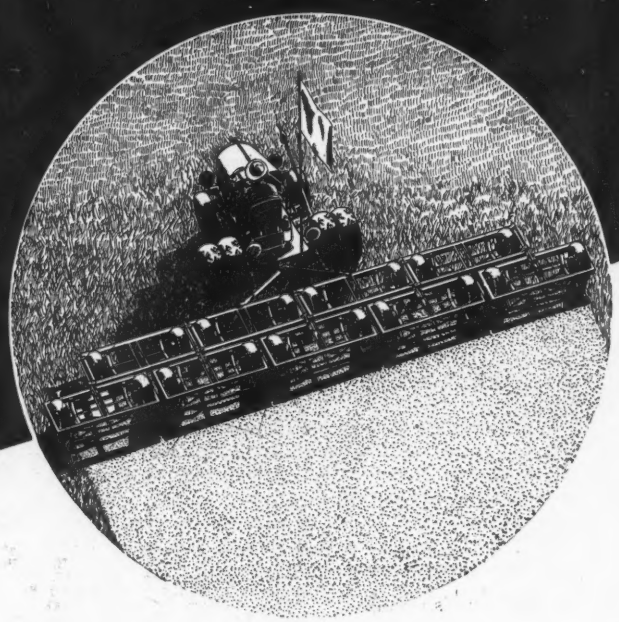

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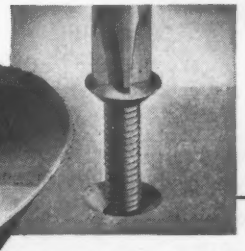

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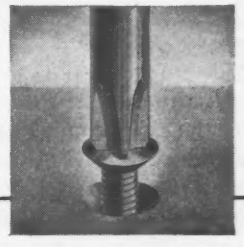

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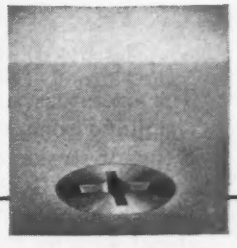

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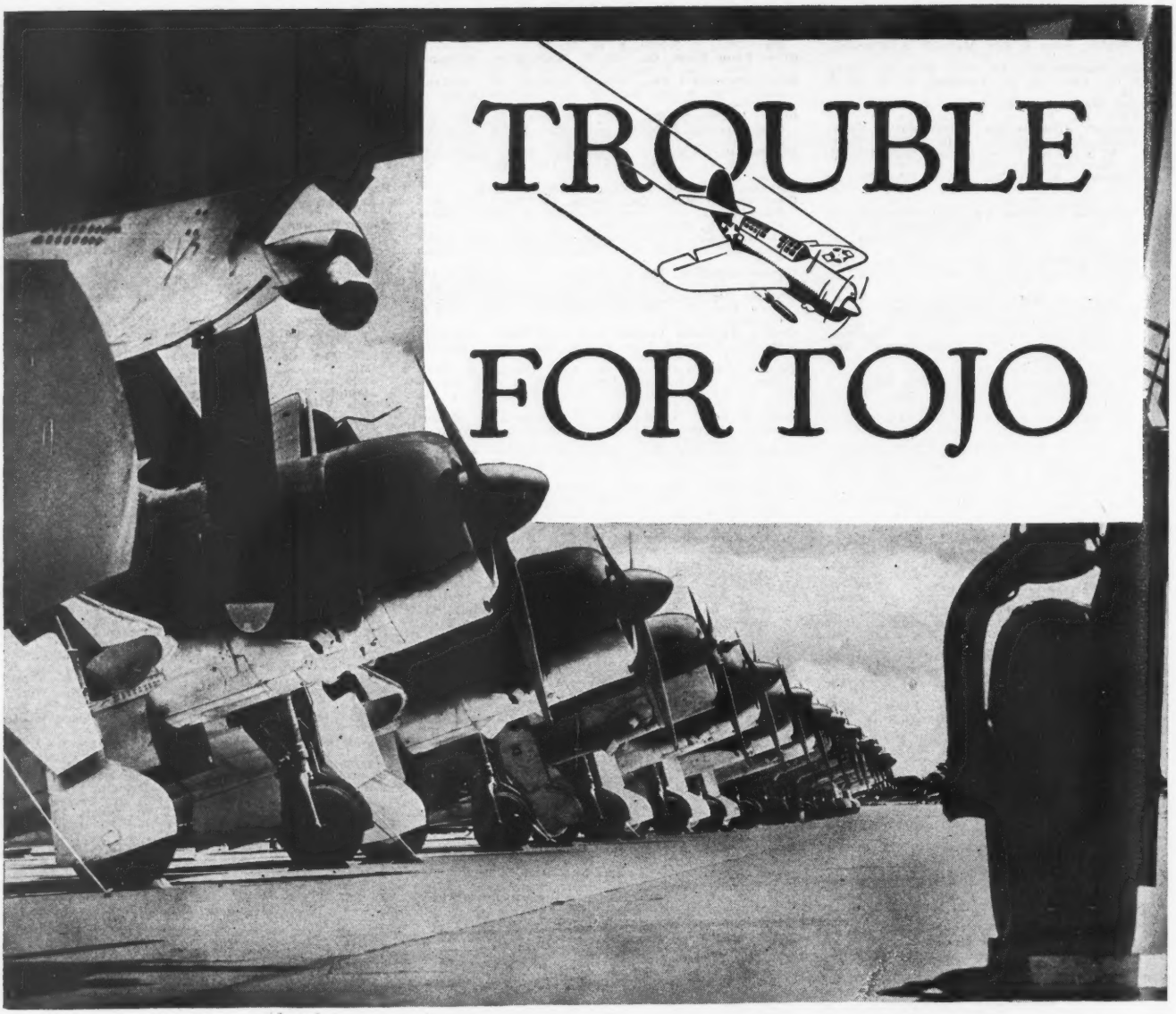

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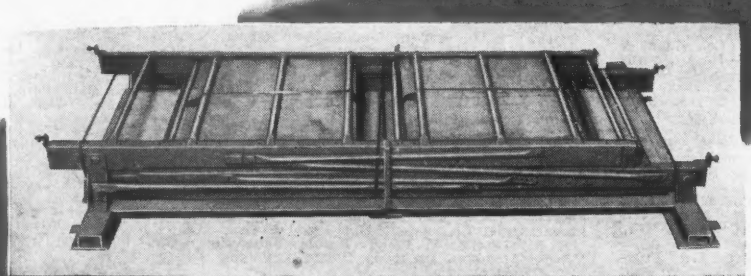

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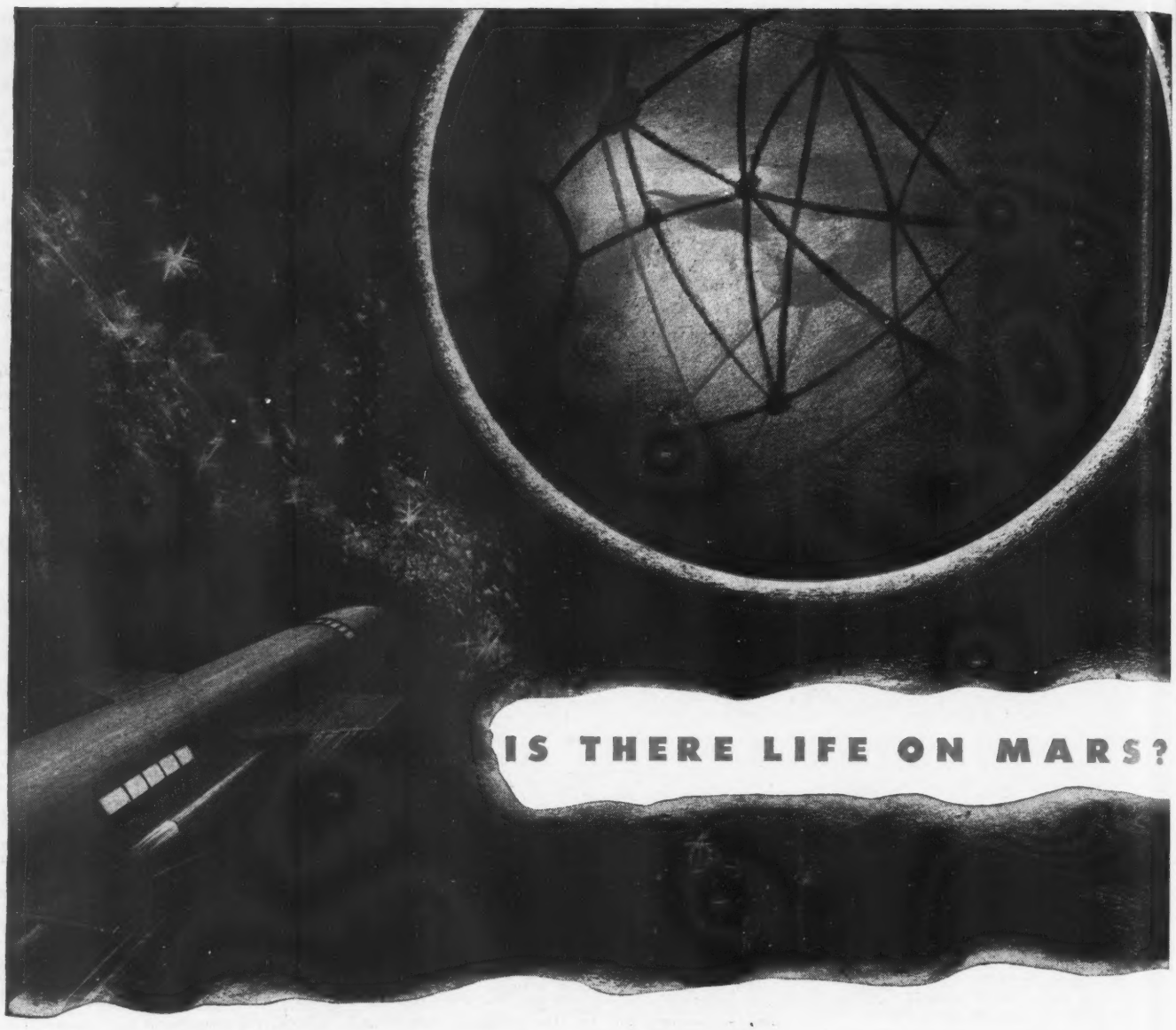

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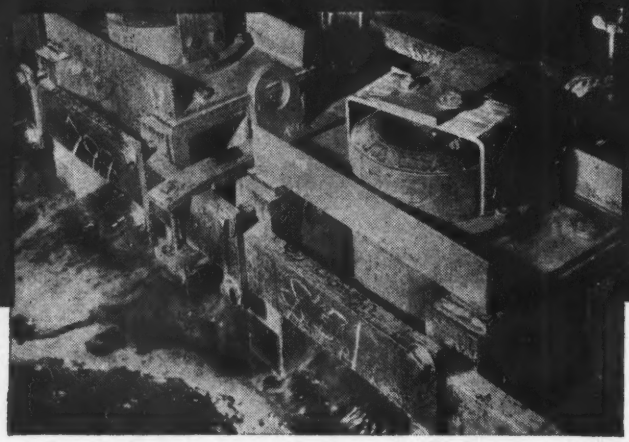

Diesel cylinders in the electroplating bath, one of the operations in the process of applying PORUS-KROME.

Applying PORUS-KROME calls for more than an electroplating tank and a knowledge of electrochemistry. It is a precise engineering process.

PORUS-KROME . . . with all its improvement in engine performance and with all the benefits of Van der Horst's long experience and expert engineering . . . is available to you in two ways. Both are under the Van der Horst patents that fully cover the process of application.

First, you can apply PORUS-KROME yourself under a Van der Horst patent license, as a number of manufacturers are now doing. Van der Horst will help you lay out your plant and guide you in its operation.

The other way is to have PORUS-KROME applied to your cylinders or other engine parts by one of the Van der Horst plants.

So the answer to the question "Who can apply PORUS-KROME?" is "You can" or "Van der Horst can". We will be glad to help you determine which is best for you.

*PORUS-KROME is hard chromium having controlled porosity and smoothness. It is applied with precision to internal combustion engine cylinder bores and other bearing surfaces to reduce wear, corrosion and scuffing and to lengthen engine life.

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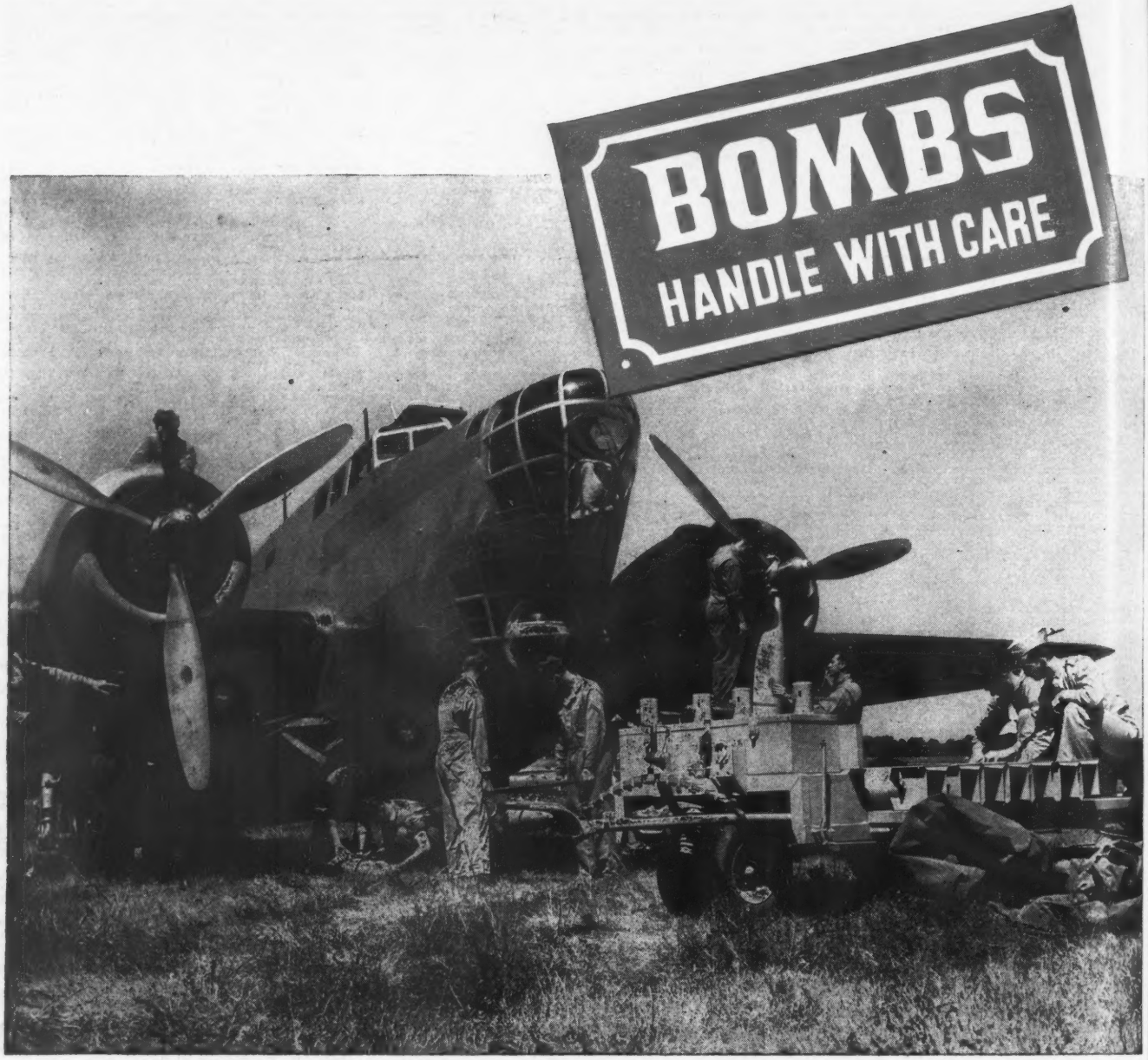

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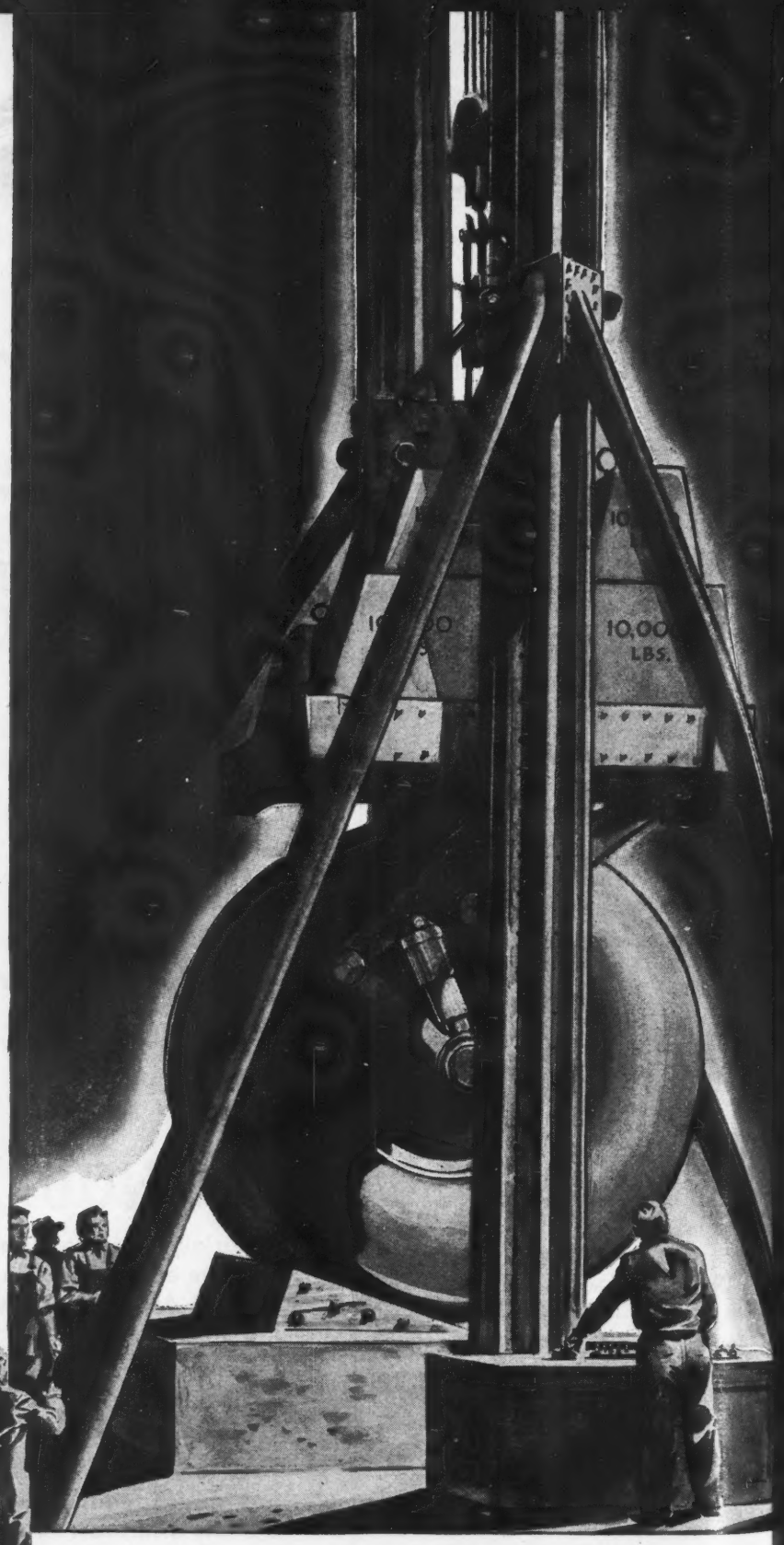

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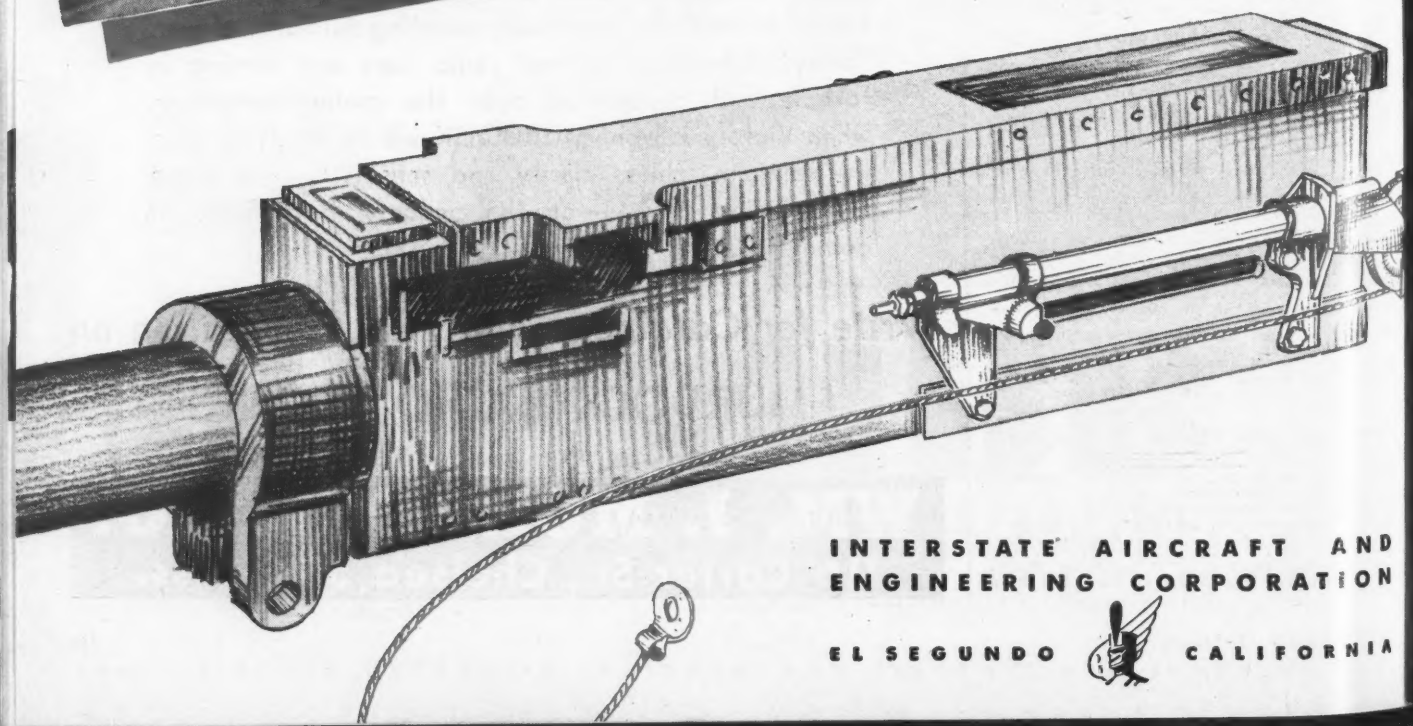

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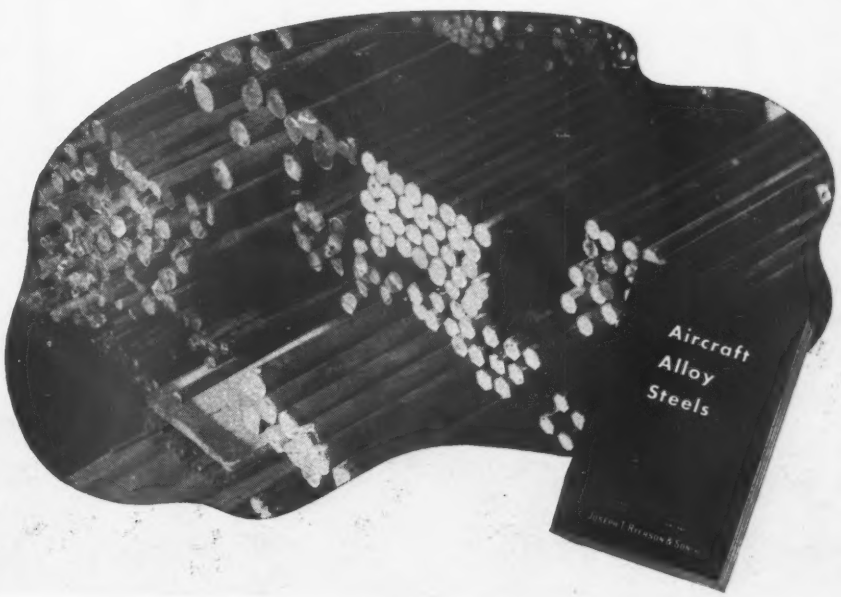

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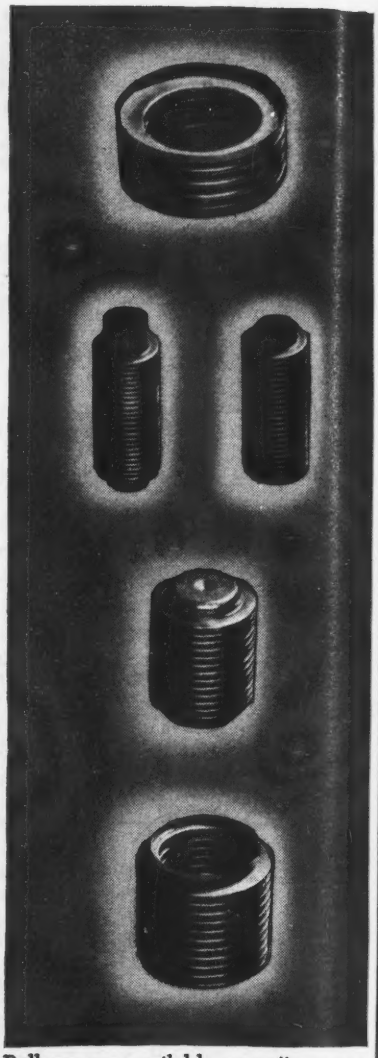

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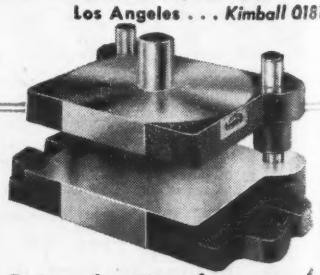

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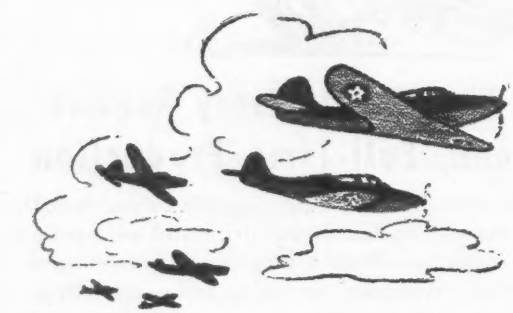

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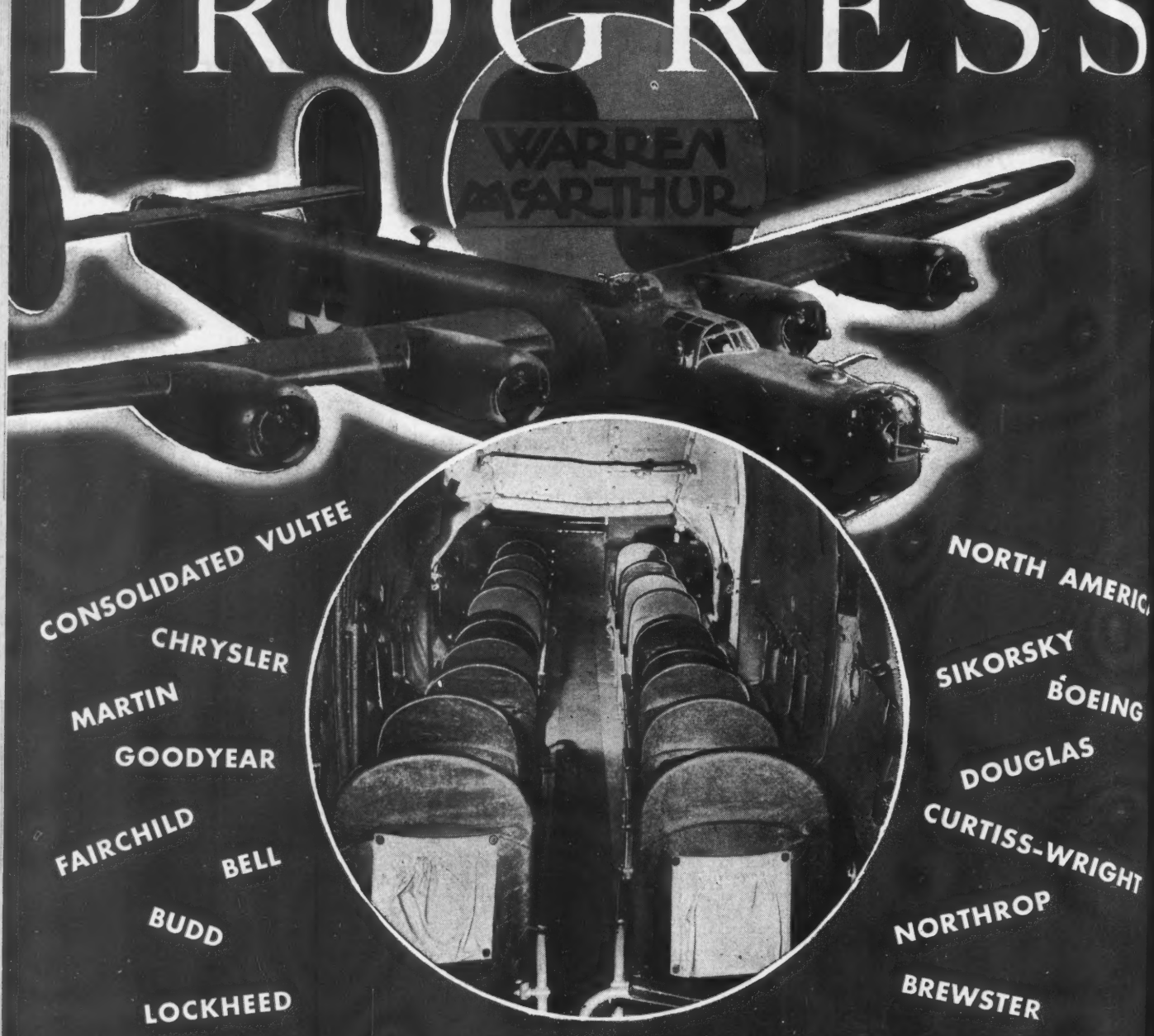

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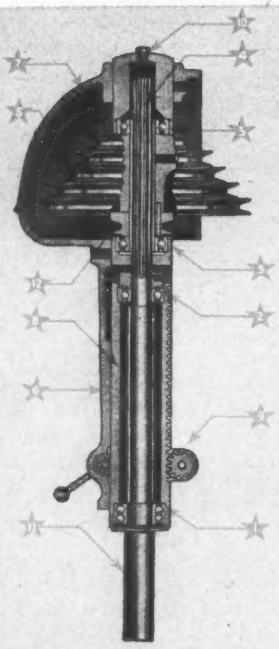

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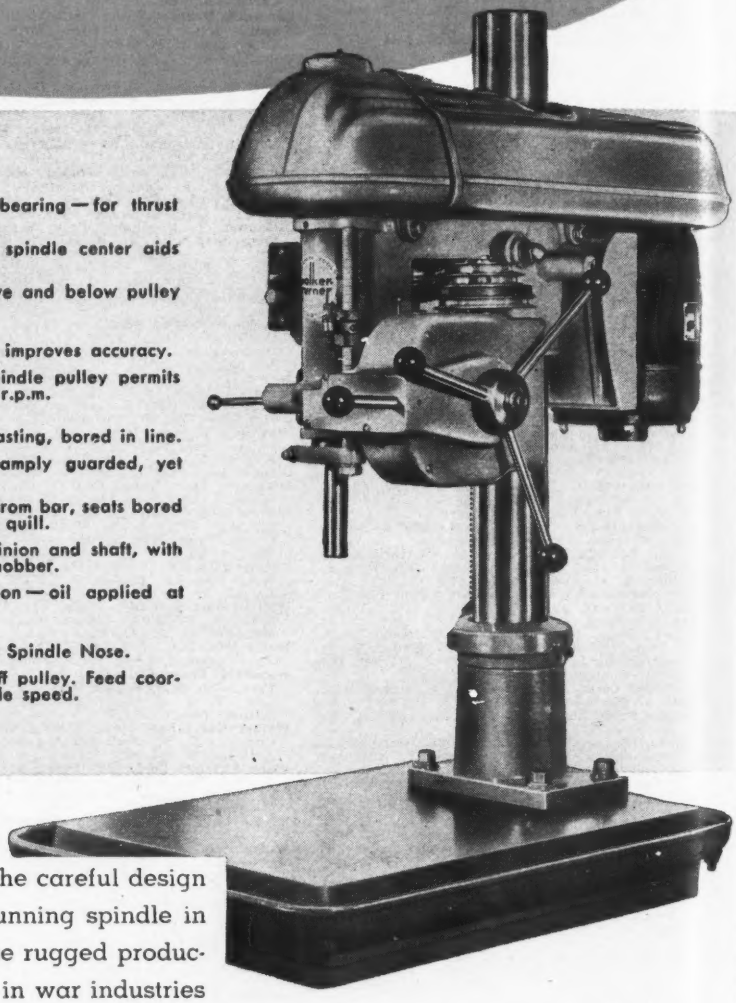

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